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CHARACTERIZATION OF MUNICIPAL WASTE COMBUSTION ASH, ASH EXTRACTS, AND LEACHATES

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CHARACTERIZATION OF MUNICIPAL WASTE COMBUSTION ASH, ASH EXTRACTS, AND LEACHATES

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TABLE OF CONTENTS

SECTION PAGE

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1-1
- 1.1 BACKGROUND 1-1
- 1.2 SCOPE OF WORK 1-2

2.0 FACILITY ZA FINDINGS 2-1
- 2.1 FACILITY ZA DESCRIPTION 2-1
- 2.2 CHEMICAL CHARACTERIZATION OF ASH 2-3
- 2.3 CHEMICAL CHARACTERIZATION OF LEACHATES 2-3
- 2.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS 2-4

3.0 FACILITY ZB FINDINGS 3-1
- 3.1 FACILITY ZB DESCRIPTION 3-1
- 3.2 CHEMICAL CHARACTERIZATION OF ASH 3-3
- 3.3 CHEMICAL CHARACTERIZATION OF LEACHATES 3-4
- 3.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS 3-5

4.0 FACILITY ZC FINDINGS 4-1
- 4.1 FACILITY ZC DESCRIPTION 4-1
- 4.2 CHEMICAL CHARACTERIZATION OF ASH 4-2
- 4.3 CHEMICAL CHARACTERIZATION OF LEACHATES 4-3
- 4.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS 4-4

5.0 FACILITY ZD FINDINGS 5-1
- 5.1 FACILITY ZD DESCRIPTION 5-1
- 5.2 CHEMICAL CHARACTERIZATION OF ASH 5-2
- 5.3 CHEMICAL CHARACTERIZATION OF LEACHATES 5-3
- 5.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS 5-5

6.0 FACILITY ZE FINDINGS 6-1
- 6.1 FACILITY ZE DESCRIPTION 6-1
- 6.2 CHEMICAL CHARACTERIZATION OF ASH 6-2
- 6.3 CHEMICAL CHARACTERIZATION OF LEACHATES 6-3
- 6.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS 6-4

7.0 SUMMARY OF RESULTS 7-1
- 7.1 CHEMICAL CHARACTERIZATION OF ASH 7-1
- 7.2 CHEMICAL CHARACTERIZATION OF LEACHATES 7-3
- 7.3 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS 7-4

REFERENCES R-1

APPENDICES

- A FINAL WORK PLAN
- B ASH RESULTS
- C LEACHATE RESULTS
- D ASH EXTRACT RESULTS

TABLES

NUMBER **PAGE**

ES-1 Major Features of MWC Facilities ES-4
ES-2 Major Features of MWC Ash Disposal Facilities ES-6
ES-3 Ash Dioxin Results ES-8
ES-4 Comparison of Ash Extract Metal Analyses Results with Leachate Metal Analyses Results ES-12
1-1 Sample Analyses 1-4
2-1 Restricted Wastes, Facility ZA 2-6
2-2 Ash Semivolatile Results - Sample ZA-AH-003, Facility ZA 2-7
2-3 Ash Dioxin Results - Sample ZA-AH-003, Facility ZA 2-8
2-4 Ash Metals Analyses, Facility ZA 2-9
2-5 Ash Conventional Analyses, Facility ZA 2-10
2-6 Leachate Semivolatile Analyses, Facility ZA 2-11
2-7 Leachate Metals Analyses, Facility ZA 2-12
2-8 Leachate Conventional Analyses, Facility ZA 2-13
2-9 Leachate Dioxin Analyses, Facility ZA 2-14
2-10 Comparison of Ash Extracts Semivolatile Analyses with Leachate Semivolatile Analyses, Ranges of Concentrations, Facility ZA 2-15
2-11 Comparison of Ash Extracts Metals Analyses with Leachate Metals Analyses, Ranges of Concentrations, Facility ZA 2-16
2-12 Comparison of Ash Extracts Conventional Analyses with Leachate Conventional Analyses, Ranges of Concentrations, Facility ZA 2-17
3-1 Ash Semivolatile Results - Sample ZB-AH-001, Facility ZB 3-7
3-2 Ash Dioxin Results - Sample ZB-AH-001, Facility ZB 3-8
3-3 Ash Metals Analyses, Facility ZB 3-9
3-4 Ash Conventional Analyses, Facility ZB 3-10
3-5 Leachate Metals Analyses, Facility ZB 3-11
3-6 Leachate Conventional Analyses, Facility ZB 3-12
3-7 Leak Detection System Sample Metals Analyses, Facility ZB 3-13
3-8 Leak Detection System Sample Conventional Analyses, Facility ZB 3-14
3-9 Comparison of Ash Extracts Metals Analyses with Leachate Metals Analyses, Ranges of Concentrations, Facility ZB 3-15
3-10 Comparison of Ash Extracts Conventional Analyses with Leachate Conventional Analyses, Ranges of Concentrations, Facility ZB 3-16
4-1 Ash Semivolatile Results - Sample ZC-AH-003, Facility ZC 4-6
4-2 Ash Dioxin Results - Sample ZC-AH-003, Facility ZC 4-7
4-3 Ash Metals Analyses, Facility ZC 4-8
4-4 Ash Conventional Analyses, Facility ZC 4-9
4-5 Leachate Metals Analyses, Facility ZC 4-10
4-6 Leachate Conventional Analyses, Facility ZC 4-11
4-7 Comparison of Ash Extracts Metals Analyses with Leachate Metals Analyses, Ranges of Concentrations, Facility ZC 4-12
4-8 Comparison of Ash Extracts Conventional Analyses with Leachate Conventional Analyses, Ranges of Concentrations, Facility ZC 4-13
5-1 Ash Semivolatile Results - Sample ZD-AH-003, Facility ZD 5-7
5-2 Ash Dioxin Results - Sample ZD-AH-003, Facility ZD 5-8

TABLES (Continued)

NUMBER PAGE

5-3 Ash Metals Analyses, Facility ZD 5-9
5-4 Ash Conventional Analyses, Facility ZD 5-10
5-5 Leachate Metals Analyses, Facility ZD 5-11
5-6 Leachate Conventional Analyses, Facility ZD 5-12
5-7 Comparison of Ash Extract Semivolatile Results to Leachate Semivolatile Results, Facility ZD 5-13
5-8 Comparison of Ash Extracts Metals Analyses with Leachate Metals Analyses, Ranges of Concentrations, Facility ZD 5-14
5-9 Comparison of Ash Extracts Conventional Analyses with Leachate Conventional Analyses, Ranges of Concentrations, Facility ZD . 5-15
6-1 Acceptable Waste, Facility ZE 6-5
6-2 Ash Dioxin Results - Sample ZE-AH-003, Facility ZE 6-6
6-3 Ash Metals Analyses, Facility ZE 6-7
6-4 Ash Conventional Analyses, Facility ZE 6-8
6-5 Leachate Semivolatile Analyses, Facility ZE 6-9
6-6 Leachate Metals Analyses, Facility ZE 6-10
6-7 Leachate Conventional Analyses, Facility ZE 6-11
6-8 Comparison of Ash Extract Semivolatile Results to Leachate Semivolatile Results, Ranges of Concentrations, Facility ZE 6-12
6-9 Comparison of Ash Extracts Metals Analyses with Leachate Metals Analyses, Ranges of Concentrations, Facility ZE 6-13
6-10 Comparison of Ash Extracts Conventional Analyses with Leachate Conventional Analyses, Ranges of Concentrations, Facility ZE . 6-14
7-1 Comparison of Ash Semivolatile Results 7-6
7-2 Ranges of Concentrations of Semivolatiles in Fly Ash, Bottom Ash, and Combined Ash from Municipal Waste Incinerators . 7-7
7-3 Ash Dioxin Results 7-8
7-4 Ranges of Concentrations of PCDDs, PCDFs, and PCBs in Fly Ash, Bottom Ash, and Combined Ash From Municipal Waste Incinerators ... 7-9
7-5 Ash Metals Analyses, Ranges of Concentrations 7-11
7-6 Ranges of Concentrations of Inorganic Constituents in Fly Ash, Combined Ash, and Bottom Ash from Municipal Waste Incinerators ... 7-12
7-7 Ash Conventional Analyses, Ranges of Concentrations 7-14
7-8 Leachate Semivolatile Results, Ranges of Concentrations 7-15
7-9 Concentrations of Organic Constituents in Leachate from Municipal Waste Landfills, Ash Monofills, and Co-Disposal Sites 7-16
7-10 Leachate Dioxin Results, Ranges of Concentrations 7-18
7-11 Concentrations of PCDDs/PCDFs in Leachates from Ash Monofills, Ranges of Concentrations . 7-19
7-12 Leachate Metals Analyses, Ranges of Concentrations 7-20
7-13 Ranges of Leachate Concentrations of Inorganic Constituents from Monofills 7-21
7-14 Leachate Conventional Analyses, Ranges of Concentrations 7-23
7-15 Ranges of Extract Concentrations of Organic Constituents From Municipal Waste Incinerator Combined Fly Ash and Bottom Ash for Three Leaching Procedures .. 7-24
7-16 Ash Extracts Metals Analyses, Ranges of Concentrations 7-25
Comparison of Literature Values with Results Obtained During CORRE Study

FIGURES

NUMBER **PAGE**

5-1 Water Quality Lysimeter Installation Detail 5-4

ACRONYMS AND DEFINITIONS

ASTM	American Society for Testing and Materials
AWQC	Ambient Water Quality Criteria
CDC	Centers for Disease Control
Co-Disposal	Disposal together of municipal solid wastes and municipal solid waste combustion ashes
CORRE	Coalition on Resource Recovery and the Environment
EP	Extraction Procedure
EPA	U.S. Environmental Protection Agency
ESP	Electrostatic Precipitator
g	grams
kg	kilograms
L	liter
MCL	Maximum Contaminant Level
mg	milligrams
Monofill	A landfill that contains only solid waste combustion ashes and residues
MSW	Municipal Solid Wastes
MWC	Municipal Waste Combustion
MWEP	Monofilled Waste Extraction Procedure, also known as SW-924
ND	Not detected.
PAHs	Polynuclear Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCDDs	Polychlorinated dibenzo-p-dioxins
PCDFs	Polychlorinated dibenzofurans
pg	picogram
ppb	parts per billion
ppt	parts per trillion
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
SMCL	Secondary Maximum Contaminant Level
SW-924	Deionized Water Extraction Test Method
TCLP	Toxic Characteristics Leaching Procedure Test Method
TDS	Total Dissolved Solids
TE	Toxicity Equivalents
TEF	Toxic Equivalency Factors
TOC	Total Organic Carbon
µg	micrograms

ACRONYMS AND DEFINITIONS (Continued)

TCDD	Tetrachloro Dibenzo-p-Dioxin
PeCDD	Pentachloro Dibenzo-p-Dioxin
HxCDD	Hexachloro Dibenzo-p-Dioxin
HpCDD	Heptachloro Dibenzo-p-Dioxin
OCDD	Octachloro Dibenzo-p-Dioxin
TCDF	Tetrachloro Dibenzofuran
PeCDF	Pentachloro Dibenzofuran
HxCDF	Hexachloro Dibenzofuran
HpCDF	Heptachloro Dibenzofuran
OCDF	Octachloro Dibenzofuran

This report has undergone internal review by the United States Environmental Protection Agency and by the Coalition on Resource Recovery and the Environment and has been subjected to peer review as well.

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EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

This report has been prepared for the United States Environmental Protection Agency (EPA) and the Coalition on Resource Recovery and the Environment (CORRE). EPA and CORRE have cosponsored this study, conducted by NUS Corporation, to enhance the data base on the characteristics of Municipal Waste Combustion (MWC) ashes, laboratory extracts of MWC ashes, and leachates from MWC ash disposal facilities.

The Coalition on Resource Recovery and the Environment (CORRE) was established to provide credible information about resource recovery and associated environmental issues to the public and to public officials. In providing information, CORRE takes no position as to the appropriateness of one technology compared to others. CORRE recognizes that successful waste management is an integrated utilization of many technologies which taken as a whole, are best selected by an informed public and informed public officials.

Incineration of municipal solid waste (MSW) has become an important waste disposal alternative because it provides an effective means of reducing the volume of MSW as well as an important source of energy recovery. Currently, 10 percent of MSW is incinerated. Based on the number of municipal waste combustion (MWC) facilities being planned across the country, this percentage is expected to increase to roughly 16-25 percent by the year 2000.

As incineration has grown in popularity, so has concern over the management of increasing volumes of ash. Ashes from MWC facilities have, on occasion, exhibited a hazardous waste characteristic as determined by the EP Toxicity Test. The debate regarding the regulatory status of ash and the representativeness and validity of the EP test continues. Congress is considering several legislative initiatives that would give EPA clear authority to develop special management standards for ash under Subtitle D of RCRA.

To conduct this study, NUS collected combined bottom and fly ash samples from five mass-burn MWC facilities and leachate samples from the companion ash disposal facilities.

The facilities sampled were selected by CORRE to meet the following criteria:

- The facilities were to be state-of-the-art facilities equipped with a variety of pollution control equipment.

- The facilities were to be located in different regions of the United States.

- The companion ash disposal facilities were to be equipped with leachate collection systems or some means of collecting leachate samples.

The identities of the facilities are being held in confidence.

The ash and leachate samples collected were analyzed for the Appendix IX semivolatile compounds, polychlorinated dibenzo-p-dioxins/polychlorinated dibenzofurans (PCDDs/PCDFs), metals for which Federal primary and secondary drinking water standards exist, and several miscellaneous conventional compounds. In addition, the ash samples were analyzed for major components in the form of oxides. The ash samples were also subjected to six laboratory extraction procedures and the extracts were then analyzed for the same compounds as the ash samples. The following six extraction procedures were used during this study:

- Acid Number 1 (EP-TOX).
- Acid Number 2 (TCLP Fluid No. 1).
- Acid Number 3 (TCLP Fluid No. 2).
- Deionized Water (Method SW-924), also known as the Monofill Waste Extraction Procedure (MWEP).
- CO_2 saturated deionized water.
- Simulated acid rain.

These extraction procedures have been used separately by a variety of researchers on MWC ashes but never have all six procedures been used on the same MWC ashes. This study was designed to compare the analytical results of the extracts from all six procedures with each other and with leachate collected from the ash disposal facilities used by the MWC facilities.

All sampling, laboratory preparation, and laboratory analysis followed stringent EPA quality assurance/quality control (QA/QC) procedures. The work was performed in accordance with the Work Plan (Appendix A) prepared by NUS for this project and with a QA/QC Plan prepared by NUS and approved by EPA. A detailed listing of the positive results is presented in a data base which is included in this Report as Appendix B (Ash), Appendix C (Leachate), and Appendix D (Ash Extracts). The results in the data base are presented as reported by the laboratories, complete with the laboratory's qualifications. Summaries of the results are presented in Sections 2.0 through 7.0. These summaries include the laboratory's qualifiers and also qualifiers placed on the data as a result of data validation.

When the laboratories did not report a positive value for a compound (i.e., the compound was not present above laboratory detection limits), the compound was reported as not detected (ND) in the tables in the text. The laboratory detection limits are the method detection limits for each specific method, unless interferences were encountered during the analysis. When interferences occurred, the laboratory adjusted the method detection limits by an appropriate dilution factor. The analytical methods used in this study were selected so that the method detection limits were well below present levels of human, environmental, or regulatory concerns.

The EPA publication "Interim Procedures for Estimating Risk Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and Dibenzofurans (CDDs and CDFs)" was used to evaluate the dioxin data. These procedures use Toxicity Equivalency Factors (TEFs) to express the concentrations of the different isomers and homologs as an equivalent amount of 2,3,7,8-Tetrachloro Dibenzo-p-Dioxin (2,3,7,8-TCDD). The Toxicity Equivalents, as calculated by using the TEFs, are then totaled and compared to the Centers for Disease Control (CDC) recommended upper level of 2,3,7,8-TCDD Toxicity Equivalency of 1 part per billion in residential soil (Kimbrough, 1984).

The major features of the five MWC facilities are provided in Table ES-1, and the major features of the MWC Ash Disposal Facilities are provided in Table ES-2. Pertinent information regarding the operating conditions of the MWC facilities, as well as information about the air pollution control equipment used by the facilities, is also provided in Table ES-1.

TABLE ES-1

MAJOR FEATURES OF MWC FACILITIES

Operational Features	Facilities				
	ZA	ZB	ZC	ZD	ZE
Facility Type	Energy recovery, continuous feed, reverse-reciprocating grate.	Energy recovery, continuous feed, reciprocating grate.	Energy recovery, continuous feed, reverse-reciprocating grate.	Energy recovery, continuous feed, reciprocating grate.	Energy recovery, continuous feed, reciprocating grate.
Startup Date	May 1986	Early 1987	January 1987	1975	September 1987
Capacity	275 tons/day/boiler 2 boilers	75 - 100 tons/day/boiler 2 boilers	400 tons/day/boiler 3 boilers	750 tons/day/boiler 2 boilers	750 tons/day/boiler 2 boilers
Combustion Temperature	1,800-2,000°F at stoker	1,800°F	1,750-1,800°F	1500-1700°F flue gas as it enters superheater	1,800°F at the grate
Temperature of air entering the boiler	Under fire: 250°F Over fire: ambient	Under fire: ambient Over fire: ambient	Under fire: 380°F Over fire: ambient	Under fire: ambient Over fire: ambient	Under fire: ambient Over fire: ambient
Volume of air entering boiler	Under fire: 70,000-90,000 lb/hour Over fire: 41,000 lb/hour	Under fire: 10,890 cu ft/min Over fire: 5,900 cu ft/min	Under fire: 34,000 ft^3/min Over fire: 11,000 ft^3/min	Under fire: 48,000 ft^3/min Over fire: 32,000 ft^3/min	
Source of ash quench water	Floor drains, rain water.	Cooling tower and boiler blowdowns, septic system discharge, floor drains.	Tertiary effluent from neighboring sewage treatment plant.	Cooling tower and boiler blowdowns.	Wastewater from plant processes.
Air pollution control equipment	Lime slurry is injected into flue gas after economizer, fabric filter baghouses.	Dry lime is injected into flue gas after economizer, fabric filter baghouses. Fly ash has phosphoric acid added to it and is agglomerated before being mixed with bottom ash.	Electrostatic precipitators.	Electrostatic precipitators	Lime slurry is injected into flue gas after economizer, electrostatic precipitators. Fly ash has water added to it and is agglomerated before being mixed with bottom ash.
Approximate waste composition	Residential: 40% Commercial/ Light Industrial: 60%	Residential: 80% Commercial/ Light Industrial: 20%	Residential: 60% Commercial/ Light Industrial: 40%	Residential: 90% Commercial/ Light Industrial: 10%	Residential: 65% Commercial/ Light Industrial: 35%

TABLE ES-1
MAJOR FEATURES OF MWC FACILITIES
PAGE TWO

Operational Features	Facilities				
	ZA	ZB	ZC	ZD	ZE
Amount of electricity generated	13.1 megawatts/hour	4.5 megawatts/hour	29 megawatts/hour	35 megawatts/hour	45 megawatts/hour
Amount of electricity used internally by facility	1.7 megawatts/hour	0.63 megawatts/hour	2.5 megawatts/hour	2.5 to 3.5 megawatts/hour	7 megawatts/hour
Material removed from incoming refuse	Large appliances, other unacceptable material diverted to demolition landfill.	Large appliances, material that will not pass through the boilers.	Large appliances, material that will not pass through the boilers.	Large appliances, material that will not pass through the boilers.	Large appliances, material that will not pass through the boilers.
Material removed from ash	Ferrous metal removed from ash at the MWC facility	None.	Ferrous metal removed from ash at the MWC facility.	Ferrous metal removed from ash at the MWC facility.	Items greater than 10 inches in diameter.

TABLE ES-2

MAJOR FEATURES OF MWC ASH DISPOSAL FACILITIES

Operational Features	Facilities				
	ZA	ZB	ZC	ZD	ZE
Facility Type	Monofill - single clay liner	Monofill - double liner (HDPE and compacted till soil)	Codisposed facility - bottom-clay liner synthetic sidewall liners	Monofill - unlined. Ash is placed over trash deposited before 1975	Monofill - double liner (HDPE and clay)
Startup Date	1986	October 1988	Landfill - 1984 Ash Disposal - 1985	1975	1987
Disposal Capacity	83,400 cubic yards	90,000-100,000 tons	Total capacity 9 million tons	Remaining capacity - 990,000 tons (6 years)	Permitted for 20 years, approximately 3.8 million tons
Amount of Ash Disposed	150 tons/day	60 tons/day	400,000 tons/year. 40% ash (2/3 of ash from ZC MWC facility).	450 tons/day	525 tons/day
Materials other than Ash disposed of	None	None	Non-burnable materials from 2 MWC facilities. Overflow from 2nd MWC facility.	None	None
Leachate Collection System	Perforated PVC pipe in a coarse aggregate envelope	Slotted HDPE	Main header - PVC collection trenches - gravel with fabric filter	None - leachate samples were collected from well points installed in the ash	Slotted HDPE
Cover	Final cover - soil and HDPE	Daily cover - sand. Non working face covered by plastic to limit leachate generation	Daily - native soil and shredded tires. Intermediate - native soils. Final - native soils.	Daily cover - soil. Intermediate - soil compacted to 10^{-6} permeability. Final - clay or HDPE.	Daily cover - soil. Intermediate - soil compacted to 10^{-6} permeability. Final - clay of HDPE.
Compaction of Ash	Only as bulldozer spreads ash in ash fill.	Bulldozer spreads and compacts ash in 8-12 inch lifts.	Track mounted compactor.	Only as bulldozer spreads ash in ash fill.	Vibrating roller.

The major findings of the ash sampling and analyses during this study are described in the following paragraphs.

Of the five ash samples (one from each facility) analyzed for the Appendix IX semivolatile compounds, four samples contained bis(2-ethylhexyl)phthalate, three contained di-n-butyl phthalate, and one contained di-n-octyl phthalate. Two PAHs, phenanthrene and fluoranthene, were detected in only one of the five ash samples. These semi-volatile compounds were detected in the parts per billion (ppb) range.

The results for the five ash samples (one from each facility) analyzed for PCDDs/PCDFs are presented in Table ES-3. This table also includes the calculated Toxicity Equivalents (TE) for each homolog of PCDD/PCDF. These TEs were calculated using EPA's methodology (EPA, March 1987). The data in this table indicate that PCDDs/PCDFs were found at extremely low levels in each ash sample. The Total TE for each ash sample was below the Centers for Disease Control (CDC) recommended 2,3,7,8-TCDD Toxicity Equivalency limit of 1 part per billion in residential soil (Kimbrough, 1984).

All 25 of the ash samples (five daily composites from each facility) were analyzed for the metals on the primary and secondary drinking water standards lists as well as for the oxides of five major ash components. Although, the results from these analyses indicate that the ash is heterogeneous, this heterogenicity appears to have been reduced by the care taken when compositing the ash samples during this study. Comparison of the results of this study with results reported in the literature (EPA, October 1987) indicates that the variability of results for each compound appears to have been reduced in this study.

Metals showing the widest range of concentrations among samples collected at each facility included barium (ZB); cadmium (ZB); chromium (ZD, ZE); copper (ZA, ZB, ZC); lead (ZD); manganese (ZA, ZC); mercury (ZE); zinc (ZB, ZD, ZE); and silicon dioxide (ZA).

Metals showing the widest variation of concentrations between the facilities included barium (results for Facility ZC are lower than the results for the other facilities); iron (results for each facility vary from all of the other facilities); lead (results for Facility ZD are higher than the results for the other facilities); mercury (results for Facilities ZC and ZD are lower than the results for the other facilities);

TABLE ES-3

ASH DIOXIN RESULTS

Compound	Toxicity Equivalency Factor (TEF)[1]	Samples (pg/g or ppt)									
		ZA-AH-003		ZB-AH-001		ZC-AH-003		ZD-AH-003		ZE-AH-003	
		Value	Toxicity Equivalents	Value	Toxicity Equivalents	Value	Toxicity Equivalents	Value	Toxicity Equivalents	Value	Toxicity Equivalents
2,3,7,8-TCDD	1	10	10	24	24	16	16	35	35	10	10
Other TCDD	0.01	206	2.06	351	3.51	281	2.81	541	5.41	120	1.2
2,3,7,8-TCDF	0.1	263	26.3	617	61.7	236	23.6	626	62.6	176	17.6
Other TCDF	0.001	1,688	1.69	3,721	3.72	1,208	1.21	2,633	2.63	1,136	1.14
1,2,3,7,8-PeCDD	0.5	33	16.5	118	59	71	35.5	ND	0	35	17.5
Other PeCDD	0.005	317	1.59	759	3.80	1,051	5.26	1,910	9.55	248	1.24
1,2,3,7,8-PeCDF	0.1	61	6.1	194	19.4	64	6.4	151	15.1	52	5.2
2,3,4,7,8-PeCDF	0.1	46	4.6	162	16.2	56	5.6	171	17.1	43	4.3
Other PeCDF	0.001	484	0.484	1,527	1.53	607	0.607	1,736	1.74	448	0.448
1,2,3,4,7,8-H_XCDD	0.04	12	0.48	40	1.6	66	2.64	86	3.44	11	0.44
1,2,3,6,7,8-H_XCDD	0.04	17	0.68	34	1.36	90	3.6	148	5.92	11	0.44
1,2,3,7,8,9-H_XCDD	0.04	28	1.12	79	3.16	120	4.8	194	7.76	22	0.88
Other H_XCDD	0.0004	154	0.062	342	0.137	925	0.37	853	0.34	104	0.042
1,2,3,4,7,8-H_XCDF	0.01	74	0.74	336	3.36	218	2.18	654	6.54	95	0.95
1,2,3,6,7,8-H_XCDF	0.01	131	1.31	524	5.24	279	2.79	660	6.60	134	1.34
1,2,3,7,8,9-H_XCDF	0.01	36	0.36	127	1.27	193	1.93	479	4.79	45	0.45
2,3,4,6,7,8-H_XCDF	0.01	5	0.05	54	0.54	70	0.70	124	1.24	20	0.20
Other H_XCDF	0.0001	281	0.0281	939	0.0939	635	0.0635	1,686	0.169	280	0.028
1,2,3,4,6,7,8-H_PCDD	0.001	159	0.159	319	0.319	1,849	1.85	1,555	1.56	122	0.122
Other H_PCDD	0.00001	140	0.0014	288	0.00288	1,511	0.0151	1,384	0.0138	0	0
1,2,3,4,6,7,8-H_PCDF	0.001	139	0.139	539	0.539	653	0.653	1,842	1.84	155	0.155
1,2,3,4,7,8,9-H_PCDF	0.001	8	0.008	48	0.048	83	0.083	119	0.119	16	0.016
Other H_PCDF	0.00001	51	0.00051	197	0.00197	254	0.00254	384	0.00384	44	0.00044
OCDD	0	313	0	544	0	6,906	0	4,519	0	294	0
OCDF	0	66	0	243	0	563	0	893	0	59	0
TOTAL TEs			74.5		211		119		189		63.7

(1) Toxicity Equivalency Factors are EPA's current recommended Factors, (EPA, March 1987).
ND Not detected below 221 pg/g.

sodium (results for Facilities ZD and ZE are lower than the results for the other facilities); calcium oxide (the results for Facilities ZA and ZB are higher than the results for the other facilities); and silicon dioxide (the results for Facility ZC are higher than the results for the other facilities).

Some additional findings of the ash sampling and analyses are as follows:

- The ashes are alkaline with the pH ranging from 10.36 to 11.85.
- The ashes are rich in chlorides and sulfates. The total soluble solids in the ashes varied from 6,440 to 65,800 ppm.
- The ashes contained unburnt total organic carbon (TOC) ranging from 4,060 ppm (0.4 percent) to 53,200 ppm (5.32 percent).

The major findings of the leachate sampling and analysis during this study are summarized in the following paragraphs.

Only four Appendix IX semivolatile compounds were found in the leachates from the ash disposal facilities. Benzoic acid was found in both leachate samples collected at one of the five ash disposal facilities. Phenol, 3-methylphenol, and 4-methylphenol were found in some of the leachate samples from one of the other facilities. All of these compounds were detected at very low levels (2-73 ppb).

PCDDs/PCDFs were only found in the leachate from one facility. The homologs found are the more highly chlorinated homologs. The data obtained during this study appears to indicate that PCDDs/PCDFs do not readily leach out of the ash in the ash disposal facilities. The low levels found in the leachates of the one facility probably originated from the solids found within the leachate samples because these samples were not filtered nor centrifuged prior to analysis.

None of the leachate samples exceeded the EP Toxicity Maximum Allowable Limits established for the eight metals in Section 261.24 of 40 CFR 261. In addition, the data from this study indicate that although the leachates are not used for drinking purposes, they are close to being acceptable for drinking water use, as far as the metals are concerned.

Some other findings of the leachate sampling and analyses are as follows:

- Sulfate values ranged from 14.4 mg/L to 5,080 mg/L, while Total Dissolved Solids (TDS) ranged from 924 mg/L to 41,000 mg/L.

- The field pH values ranged from 5.2 to 7.4.

- Ammonia (4.18-77.4 mg/L) and nitrate (0.01-0.45 mg/L) were present in almost all leachate samples.

- Total Organic Carbon values ranged from 10.6 to 420 ppm.

The major findings from the analysis of the ash extracts during this study are summarized as follows:

- Of the five composite samples of the deionized water (SW-924) extracts analyzed for the Appendix IX semivolatile compounds (one from each facility), only one sample contained low levels of benzoic acid (0.130 ppm).

- None of the extracts contained PCDDs/PCDFs. These data confirm the findings of the actual field leachate samples that PCDDs/PCDFs are not readily leached from the ash.

The data obtained during the metals analyses of the ash extracts indicate that, in general, the extracts from the EP Toxicity, the TCLP 1, and the TCLP 2 extraction procedures have higher metals content than the extracts from the deionized water (SW-924), the CO_2, and the Simulated Acid Rain (SAR) extraction procedures. The EP Toxicity Maximum Allowable Limits for lead and cadmium were frequently exceeded by the extracts from the EP Toxicity, TCLP 1, and TCLP 2 extraction procedures. One of the extracts from the EP Toxicity extraction procedure also exceeded the EP Toxicity Maximum Allowable Limit for mercury.

None of the extracts from the deionized water (SW-924), the CO_2, and the Simulated Acid Rain (SAR) extraction procedures exceeded the EP Toxicity Maximum Allowable Limits. In addition, the majority of the extracts from these three extraction procedures also met the Primary and Secondary Drinking Water Standards for metals.

Table ES-4 compares the range of concentrations of the metals analyses of the ash extracts with the range of concentrations for leachate as reported in the literature (EPA, October 1987) and the range of concentrations for the leachates as determined in this study. For the facilities sampled during this study, the data in Table ES-4 indicate that the extracts from the deionized water (SW-924), the CO_2, and the SAR extraction procedures simulated the concentrations for lead and cadmium in the field leachates better than the extracts from the other three extraction procedures.

TABLE ES-4

COMPARISON OF ASH EXTRACT METAL ANALYSES RESULTS WITH LEACHATE METAL ANALYSES RESULTS

Parameter	Samples (µg/L)							
	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	CO_2 Extracts	DI H_2O Extracts	SAR Extracts	Leachate (Literature)(1)	Leachate (CORRE)
Arsenic	ND-31	ND	ND-60	ND-53	ND-45	ND	5-218	ND-400
Barium	23-455	161-1,850	12-809	126-530	139-3,050	129-3,960	1,000	ND-9,220
Cadmium	25-1,200	ND-1,150	ND-1,560	ND-354	ND-7.6	ND-6.0	ND-44	ND-4
Chromium	ND-86	ND-8.0	ND-799	ND-9.8	ND-16	ND-10	6-1,530	ND-32
Copper	24-5,170	5-858	5.4-1,400	8.8-620	12-534	8.5-610	22-24,000	ND-12
Iron	ND-82,000	ND-7,220	ND-162,000	ND-304	ND-115	ND-97	168-121,000	108-10,500
Lead	ND-19,700	ND-10,500	ND-26,400	ND-504	ND-3,410	ND-3,940	12-2,920	ND-54
Manganese	250-8,540	ND-5,170	3.8-7,370	ND-2,390	ND-20	ND-6.4	103-4,570	310-18,500
Mercury	ND-203	ND-3.8	ND-4.6	ND-155	ND-0.96	ND-1.1	1-8	ND
Selenium	ND	ND	ND	ND	ND	ND-23	2.5-37	ND-340
Silver	ND	ND	ND	ND-16	ND	ND	70	ND
Sodium	33,600-225,000	1,380,000-1,640,000	38,700-228,000	24,800-168,000	24,100-209,000	24,200-201,000	200,000-4,000,000	188,000-3,800,000
Zinc	67-95,600	9.7-79,500	26-164,000	5-127,000	5.4-1,340	12-1,290	ND-3,300	5.2-370

TABLE ES-4
COMPARISON OF ASH EXTRACT METAL ANALYSES RESULTS WITH LEACHATE METAL ANALYSES RESULTS
PAGE TWO

Parameter	Samples (µg/L)							
	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	CO_2 Extracts	DI H_2O Extracts	SAR Extracts	Leachate (Literature)[1]	Leachate (CORRE)
Aluminum Oxide*	ND-150,000	ND-62,800	ND-152,000	ND-90,700	ND-203,000	ND-118,000	NR	ND-920
Calcium Oxide*	592,000-4,810,000	666,000-2,750,000	692,000-3,640,000	398,000-1,920,000	141,000-1,740,000	142,000-1,800,000	21,000	64,600-8,390,000
Magnesium Oxide*	27,300-130,000	55-375,000	623-137,000	207-59,300	21-379	12-430	NR	14,800-367,000
Potassium Monoxide*	10,100-189,000	14,600-210,000	15,100-1,110,00	12,300-155,000	13,100-189,000	14,500-181,000	21,500	79,700-1,620,000
Silicon Dioxide*	5,090-98,700	379-51,700	820-143,000	418-71,800	402-3,990	364-3,770	NR	470-15,300

ND Not Detected.
NR Not Reported in the literature.
(1) EPA, October 1987.
* The ash extracts were analyzed as ions for these compounds and reported as oxides. The leachates were analyzed and are reported as ions for these compounds.

1

1.0 INTRODUCTION

This report, "Characterization of Municipal Waste Combustion Ash, Ash Extracts and Leachates," has been prepared for the United States Environmental Protection Agency (EPA) and the Coalition on Resource Recovery and the Environment (CORRE) in response to Work Assignment Number 90 under EPA Contract Number 68-01-7310.

This study was initiated by Ms. Gerry Dorian of EPA and Dr. Walter Shaub of CORRE.

1.1 BACKGROUND

Prior to the passage of the Resource Conservation and Recovery Act of 1976 (RCRA), disposal of municipal solid waste (MSW) and the ash from municipal waste combustion (MWC) facilities was not regulated by EPA but was regulated primarily by individual states and local municipalities. With the passage of RCRA, the disposal of MSW has been regulated under Subtitle D of RCRA. The regulations in Subtitle D stipulate that any municipal waste disposal facility that does not meet the criteria promulgated under RCRA must be closed. Because of the need to meet these criteria, there has been a steady decrease in the number of sites available for MSW disposal.

Incineration of municipal solid waste (MSW) has become an important waste disposal alternative because it provides an effective means of reducing the volume of MSW as well as an important source of energy recovery. Currently 10 percent of MSW is incinerated. Based on the number of municipal waste combustion (MWC) facilities being planned across the country, this percentage is expected to increase to roughly 16-25 percent by the year 2000.

As incineration has grown in popularity, so has concern over the management of increasing volumes of ash. Ashes from MWC facilities have, on occasion, exhibited a hazardous waste characteristic as determined by the EP Toxicity Test. The debate regarding the regulatory status of ash and the representativeness and validity of the EP test continues. Congress is considering several legislative initiatives that would give EPA clear authority to develop special management standards for ash under Subtitle D of RCRA.

In the meantime, EPA and CORRE have cosponsored this study conducted by NUS to enhance the data base on the characteristics of MWC ashes, laboratory extracts of MWC ashes, and leachates from MWC ash disposal facilities.

The Coalition on Resource Recovery and the Environment (CORRE) was established to provide credible information about resource recovery and associated environmental issues to the public and to public officials. In providing information, CORRE takes no position as to the appropriateness of one technology compared to others. CORRE recognizes that successful waste management is an integrated utilization of many technologies which taken as a whole, are best selected by an informed public and informed public officials.

1.2 SCOPE OF WORK

NUS collected samples of fresh ash from five mass-burn MWC facilities. All of the ash samples collected were combined fly ash and bottom ash samples.

The facilities sampled were selected by CORRE to meet the following criteria:

- The facilities were to be state-of-the-art facilities equipped with a variety of pollution control equipment.

- The facilities were to be located in different regions of the United States.

- The companion ash disposal facilities were to be equipped with leachate collection systems or some means of collecting leachate samples.

The identities of the facilities are being held in confidence.

These samples were submitted to laboratories for chemical analyses. In addition, these ash samples were subjected to six different laboratory extraction procedures and the extracts were then analyzed. NUS also collected leachate samples from the five MWC ash disposal facilities used by the MWC facilities. The leachate samples were also sent to a laboratory for analysis. The analyses performed on each type of sample are outlined in Table 1-1.

Collection of the ash and leachate samples generally followed the Work Plan prepared for this project (NUS, December 1988). A copy of this Work Plan is included in Appendix A. Five composite ash samples were collected from each of the five MWC facilities. The ash samples were collected each day over 5 days (Monday-Friday) of facility operation. Starting times for sample collection were different each day so that a wide range of time could be covered. Ash grab samples were collected at a fixed point each hour for 8 hours. These 8 grab samples were placed in a 5-gallon container for compositing into each day's 8-hour composite sample.

Originally, the ash samples were to be collected using the method outlined in ASTM D234-86 Standard Method for Collection of a Gross Sample of Coal, Condition B, full-stream cut. However, because of the configuration of the ash handling equipment at each facility, minor modifications to this sampling method were needed to collect the most representative samples from each facility. A description of how the samples were collected at each facility is presented in the appropriate Facility Description (Sections 2.0 through 6.0).

Prior to analysis, the samples were prepared in the laboratory by implementing the following procedures:

- Each composite sample was passed over a 2-inch screen. Material passing the 2-inch screen was set aside. Material larger than 2 inches was subjected to repeated blows with a 5-pound sledge hammer dropped from a height of 1 foot. If a piece did not break after being subjected to three blows of the hammer, it was weighed, the weight recorded, and the piece was discarded. Material that broke was then reduced in size to pass the 2-inch screen and recombined with the original material that was smaller than 2 inches.

- Each composite sample was dried at 105°C and crushed to pass a 3/8-inch screen and riffled or coned and quartered to obtain a 1,000 gram sample. The sample was then properly labeled and stored in a clean, dry, cool, secure area. For further details, see ASTM Standard D346.

TABLE 1-1

SAMPLE ANALYSES

Matrix	Preparation	Analyses	Comments
Ash	Screened, Crushed, Dried, Crushed, Riffled, or Coned and Quartered	Metals(1)	
		Conventionals(2)	
		Appendix IX - Semivolatiles	Only 1 sample/facility
		PCDDs/PCDFs	Only 1 sample/facility
		PCBs	Only 1 sample from 2 different facilities
Leachates	Laboratory filtered and added HNO_3 to $pH<2$	Metals(3)	
	Laboratory added H_2SO_4 to $pH<2$ (added to ZA samples in field)	TOC; NH_3-N	
		Alkalinity as $CaCO_3$	
		TDS; NO_3-N; SO_4; PO_4	
		Cl; Kjeldahl Nitrogen (ZA samples only)	
		Appendix IX - Semivolatiles	
		PCDDs/PCDFs	
		PCBs	Only 1 sample from 2 different facilities
Ash Extracts		Metals(4)	
		Conventionals(5)	
		Appendix IX - Semivolatiles	Only on 1 composite ash extract from each facility
		PCDDs/PCDFs	Only on 1 composite ash extract from each facility
		PCBs - Deionized water extract - Facilities ZA and ZE	Only on 1 composite ash extract from each of 2 facilities

(1) Metals: As, Ba, Cd, Cr, Pb, Hg, Se, Ag, Na, Cu, Fe, Mn, and Zn. Oxides of Al, Si, Ca, Mg, K.

(2) Conventionals: TOC, total soluble salts, NH_3-N, NO_3-N, SO_4, PO_4, CO_3, Cl, moisture content, and pH.

(3) Metals: Soluble forms of Al, As, Ba, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Si, Ag, Na, Zn (Nickel analyzed only on samples from facility ZA).

(4) Metals: Al, As, Ba, Cd, Ca, Cr, Cu, Fe, Pb, Mg, Mn, Hg, K, Se, Si, Ag, Na, Zn.

TABLE 1-1
SAMPLE ANALYSES
PAGE TWO

(5) Conventionals:

Facility ZA: NO_3-N, PO_4, Cl, SO_4, TDS, TOC, NH_3-N, Alkalinity on all extracts.
Facility ZB: NO_3-N, PO_4, Cl, SO_4 - TCLP 1; TCLP 2; EPTOX; and CO_2 extracts.
NO_3-N, PO_4, Cl, SO_4, TDS, TOC, NH_3-N, Alkalinity - Deionized Water extract.
PO_4, TOC - SAR extract.
Facilities ZC, ZD, ZE:
NO_3, PO_4, Cl, SO_4, NH_3-N - TCLP 1; TCLP 2; EPTOX; and CO_2 extracts.
NO_3, PO_4, Cl, SO_4, TDS, TOC, NH_3-N, Alkalinity - Deionized Water extract.
PO_4, TOC, NH_3-N - SAR extract.

Metals and Appendix IX semi-volatile compounds were analyzed in strict adherence to the EPA third edition of SW-846.

The conventional parameters were analyzed according to the applicable methods described in the "Methods for Chemical Analysis of Water and Wastewaters," EPA-600/2-79-020, March 1983. Where necessary, a DI extraction was done on the ash, except for NH_3-N where a 2M KCl solution was used.

PCBs, PCDDs, and PCDFs were analyzed in the homolog form according to the procedures described in Appendix B of the December 1988 Work Plan. In addition, for the PCDDs and PCDFs the concentrations of the individual 2, 3, 7, 8 isomers were determined for each homolog.

The ash samples were analyzed as outlined in Table 1-1. In addition, a portion of the prepared samples were subjected to the following six laboratory extraction procedures:

- Acid Number 1 (EP-TOX).
- Acid Number 2 (TCLP Fluid No. 1).
- Acid Number 3 (TCLP Fluid No. 2).
- Deionized Water (Method SW-924), also known as the Monofill Waste Extraction Procedure (MWEP).
- CO_2 saturated deionized water.
- Simulated acid rain.

These extraction procedures have been used separately by a variety of researchers on MWC ashes but never have all six procedures been used on the same MWC ashes. This study was designed to compare the analytical results of the extracts from all six procedures with each other and with leachate collected from the ash disposal facilities used by the MWC facilities.

The laboratory adhered to the appropriate Federal Register leaching requirements for the first three methods. The extraction solutions and the extraction procedures used for the CO_2 saturated deionized water and the simulated acid rain are given in Appendix A of the Work Plan (NUS, December 1988). The SW-924 method is described in Vol. I "Characterization of MWC Ashes and Leachates from Landfills, Monofills, and Co-Disposal Sites," EPA, October 1987. The extracts from the ash were analyzed as outlined in Table 1-1.

Leachate samples were collected from the five facilities to which the individual MWC facilities sent ashes for disposal. At two of the ash disposal facilities, two grab samples were collected from leachate collection sumps. At another ash disposal facility, one grab sample was collected from a valve on the leachate collection line. At the fourth ash disposal facility, two grab samples were collected from one shallow water quality lysimeter, and a third grab sample was collected from a second shallow water quality lysimeter. Seven leachate samples were collected from the fifth ash disposal facility: three in February 1988, two in November 1988, and two in June 1989. All seven samples were grab samples collected from the same leachate collection manhole. The leachates collected from this fifth facility were collected and analyzed by NUS under a separate contract to EPA. The results of this study were reported in detail in a separate report (EPA, August 1989). Since results of that study are very pertinent to this study, the results are repeated in the present report.

The leachate samples were shipped to the laboratories for the analyses listed in Table 1-1. Because of difficulties in shipping or obtaining preservatives, the leachates samples collected during this study were not preserved in the field, but were packed in ice and shipped immediately to the laboratory. The laboratories were instructed to immediately add the required preservatives in the laboratory after filtering, as applicable. Since the laboratories preserved the samples within 48 hours of sample collection, the samples were not adversely affected.

All sampling and analytical procedures used in this project followed stringent Quality Assurance/Quality Control (QA/QC) requirements as outlined in a Quality Assurance Project Plan prepared for EPA by NUS and approved by EPA's QA Officer in February 1988 (NUS, February 1988).

Summaries of the results of the analyses of the samples from each MWC Facility are presented in Sections 2.0 through 6.0. An overall summary is presented in Section 7.0. The tables in these sections are presented at the end of each section.

A detailed listing of the positive results, as reported by the laboratories, is presented in a data base which is included in this report as Appendix B (ash), Appendix C (leachate), and Appendix D (ash extracts). When the laboratories did not report a positive value for a compound (i.e. the compound was not present above laboratory detection limits), the compound was reported as not detected (ND) in the tables in the text. The laboratory detection limits are the method detection limits for each specific method, unless interferences were encountered during the analysis. When interferences occurred, the laboratory adjusted the method detection limits by an appropriate dilution factor. The analytical methods used in this study were selected so that the method detection limits were well below present levels of human, environment or regulatory concerns.

The EPA publication "Interim Procedures for Estimating Risk Associated with Exposures to Mixtures of Chlorinated Dibenzo-p-Dioxins and -Dibenzofurans (CDDs and CDFs)" was used to evaluate the Dioxin data. These procedures use Toxicity Equivalency Factors (TEFs) to express the concentrations of the different isomers and homologs as an equivalent amount of 2,3,7,8-Tetrachloro Dibenzo-p-Dioxin

(2,3,7,8-TCDD). The Toxicity Equivalents, as calculated by using the TEFs, are then totaled and compared to the Centers for Disease Control (CDC) recommended upper level of 2,3,7,8-TCDD Toxicity Equivalency of 1 part per billion in residential soil (Kimbrough, 1984).

2

2.0 FACILITY ZA FINDINGS

2.1 FACILITY ZA DESCRIPTION

Facility ZA consists of two mass-burn, water-wall boilers. Refuse is charged into the boilers by overhead cranes, moves inside the boilers on grates, and is discharged into ash quench reactors on the bottom of the boilers. A lime slurry is added to the flue gas where it is mixed with the fly ash. This mixture is then collected in baghouses and mixed in with the bottom ash for disposal. The steam generated at the facility is used to produce electricity, which is sold to a local utility. The following details provide operational information for this facility.

Startup Date:	May 1986.
Refuse Feed Rate:	275 tons/day/boiler.
Operating Temperature:	1,800° - 2,000° F at the stoker.
Residence Time:	Approximately 1-1/2 hours in the boiler where the grates can be slowed to allow wet loads more time to dry out; 1-1/2 hours from ash discharge to ash pile.
Backup Fuel:	Natural gas - is used if operating temperature drops below 1,500° F. Has only been used at startups and shutdowns.
Air Temperature into Furnace:	Underfire air - 250° F; Overfire air - ambient temperature.
Air Feed Rate:	Underfire air - varies, normally between 70,000-90,000 lbs./hour. Overfire air - 40,000 lbs./hour.
Refuse Feed Method:	Old and new refuse is mixed with an overhead crane. Mixed refuse is loaded into boilers with the overhead crane.
Trash Accepted:	Residential, commercial, industrial waste generated in local community. Restrictions are listed in Table 2-1. Medical waste is being accepted. No sewage sludge is accepted. No

	known waste oil program in the state. Some waste oil comes into the facility.
Normal Moisture Content of Ash: (As measured by the facility)	20 - 30%.
Source of Ash Quench Water:	Ash quench water consists of water from floor drains and some rain water.
Electricity Generated:	13.1 Megawatts/hour.
Electricity Used by the Facility:	1.7 Megawatts/hour.

Ash Handling Equipment

A lime slurry is injected into the flue gas just inside the quench reactor to neutralize acid gases formed in the boiler. The flue gas then passes through the baghouses, where the fly ash-lime mixture is removed from the flue gases. This mixture is transported back to the ash dischargers on the bottom of each boiler, where it is mixed with the bottom ash.

The fly ash is mixed with the bottom ash in the ash discharger. From there, the ash mixture is discharged onto a large shaker conveyor, travels to a grizzly where large items are removed, is discharged onto a small shaker conveyor, and then is discharged onto an inclined conveyor belt. The ferrous material is removed at the top of the conveyor by a rotating electromagnet. The ash falls from the inclined conveyor belt onto the ash pile. The ash is loaded onto trucks for transportation to the ash fill. After passing through a trommel, where small particles of ash clinging to the metal are removed, the ferrous material is trucked to a steel manufacturer.

The ash samples at this facility were collected as the ash came off the inclined belt. The ash had a tendency to segregate itself at the top of the inclined belt, with the larger particles coming directly off the belt and the finer, wetter particles sticking to the belt. These fine, wet particles started back down the underside of the belt and were scraped off the belt about 1 foot below the top of the conveyor. After the ferrous material was removed, the samples were collected so that half of each hourly grab sample consisted of the larger particles and half of the sample consisted of the finer particles.

2.2 CHEMICAL CHARACTERIZATION OF ASH

Table 2-2 presents the results of the semivolatile analysis of the ash samples from Facility ZA. The data presented in the table indicate that three phthalates were detected in sample ZA-AH-003, the only sample from this facility analyzed for the Appendix IX semivolatiles. The di-n-butyl phthalate appears to be the result of laboratory contamination. The other compounds indicate the presence of plastic material in the ash. This same sample also contained 107 ng/g (parts per billion (ppb)) of dichlorobiphenyl (PCB). This was the only PCB congener detected in this sample.

Table 2-3 presents the results of the polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD/PCDF) analyses of sample ZA-AH-003. Toxicity equivalency values were calculated according to EPA's methodology (EPA, March 1987) and are also presented in this table. The data in this table indicate that the PCDDs/PCDFs levels found in the ash are substantially below the Centers for Disease Control (CDC) recommended upper level of 2,3,7,8-TCDD toxicity equivalency of 1 part per billion in residential soil (Kimbrough, 1984).

The results of the metals analyses for the ash from this facility are presented in Table 2-4. The data presented in this table indicate that, except for copper, manganese, and silicon dioxide, the results were fairly constant during the week of sampling.

The results for the conventional analyses are presented in Table 2-5. The data in this table indicate that the results were also fairly constant during the week, except for TOC, and ammonia.

2.3 CHEMICAL CHARACTERIZATION OF LEACHATES

The MSW facility unit accepting ash from MWC Facility ZA is lined and is used exclusively for the disposal of ash from Facility ZA. The leachate from the ash disposal facility for MWC Facility ZA was not sampled at the same time that the ash was sampled. However, NUS collected samples of the leachate in February and November 1988 and in June 1989 under a separate contract with EPA. The samples are grab samples collected from the same leachate collection manhole. The manhole was sampled, accumulated water was removed, and the manhole was allowed to refill with leachate that had been stored in the ash fill. The manhole was then resampled. The results of the 1988 sampling events were reported in detail previously (EPA, August 1989) and are summarized here, together with the results of the 1989 sampling event.

The results for the semivolatile analysis of these samples are presented in Table 2-6. As shown in this table, phenol was detected on two different occasions, whereas 3-methylphenol and 4-methylphenol were each detected once.

The results for the metals analysis of the leachate samples are shown in Table 2-7. None of the metals detected exceeded the EP Toxicity Maximum Allowable Limit. Although the leachates are not required to meet Drinking Water Standards, a comparison of the leachate results with the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988) was made. This comparison indicates that the majority of the metals results met these standards in the leachates.

Table 2-8 presents the results of the conventional analyses of the leachate samples. TDS values ranged from 13,700 mg/L to 41,000 mg/L, and the pH values ranged from 6.7 to 7.4. Chloride, TDS, and Sulfate exceeded their Secondary Drinking Water Standards in all of the leachate samples.

The results of the dioxin analysis of the leachate samples are presented in Table 2-9. This table shows that only very small amounts of the more highly chlorinated homologs (hepta-CDD, octa-CDD, and hepta-CDF) were found in the leachate samples.

No PCBs were detected in ZA-LE-006, the only leachate sample analyzed for PCBs.

2.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS

No PCDDs/PCDFs or PCBs were detected in the composite sample from the Deionized Water Extracts of the ash from Facility ZA.

Table 2-10 presents the results of the Appendix IX semivolatile analysis of the composite sample from the Deionized Water Extracts (SW-924) of the ash from MWC Facility ZA. Benzoic acid (130 ppb) was the only Appendix IX semivolatile compound found in this composite sample. For comparison, this table also presents the range of results of the Appendix IX semivolatile analyses of the actual leachate samples from the ashfill serving this facility. The leachate from the ashfill contained very low levels of phenol (up to 32 ppb); 3-methylphenol (up to 6 ppb); and 4-methylphenol (up to 6 ppb).

Table 2-11 presents the range of results of the metals analyses of ash extracts from MWC Facility ZA and the range of results for leachate samples from the ashfill serving this facility. For comparison, this table also lists the EP Toxicity Maximum Allowable Limits, and the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988).

The results presented in Table 2-11 indicate that the extracts from the EP Toxicity Extraction technique generally contain higher concentrations of metals than the extracts produced by the other extraction techniques. The data in this table also indicate that the extracts from the deionized water extraction technique (SW-924) generally contain lower concentrations of metals than the extracts produced by the other extraction techniques.

For this facility, the extracts from the EP toxicity extraction technique are the only ones that exceeded the EP Toxicity Maximum Allowable Limits established in Section 261.24 of 40 CFR 261 for cadmium, lead, and mercury.

Although the ash extracts would not be required to meet Drinking Water Standards, a comparison of the ash extract results with the Drinking Water Standards was made. This comparison indicates that the majority of the metals results met these standards.

Table 2-12 presents the range of results of the conventional analyses of the ash extracts from MWC Facility ZA and the range of results of the leachate samples from the ashfill serving this facility. For comparison, this table also lists the Primary Drinking Water Standards for nitrate, as well as the Secondary Drinking Water Standards for chloride, sulfate, and Total Dissolved Solids (TDS). The data in this table indicate that the results for the conventional compounds obtained from the deionized water extraction technique (SW-924) are generally lower than the results from the other extraction techniques.

TABLE 2-1

RESTRICTED WASTES
FACILITY ZA

ALL COVERED VEHICLES MUST LIFT OR ROLL BACK TARP FOR INSPECTION AT SCALE PRIOR TO ENTERING FACILITY OR TIP OUT ON FLOOR AS DIRECTED

PROHIBITED WASTES

NO
- Wallboard/Drywall
- Nonburnable Construction Materials
- Sealed Drums or Containers
- Tar/Asphalt
- Tires
- Bales
- Infectious Materials
- Major Auto Parts (Batteries, Fenders, etc.)
- Other Unacceptable Items

NO HAZARDOUS WASTE PER STATE / FEDERAL REGULATIONS

TRUCKS WITH UNACCEPTABLE LOADS SHALL BE:

- DENIED ENTRY OR
- RELOADED AND REDIRECTED TO LANDFILL

ALL VEHICLES
SUBJECT TO INSPECTION

TABLE 2-2

ASH SEMIVOLATILE RESULTS - SAMPLE ZA-AH-003
FACILITY ZA

Parameter	Ash Sample Result (µg/kg)
Bis(2-ethylhexyl)phthalate	250,000
Di-n-octyl phthalate	2,000T
Di-n-butyl phthalate	430JB

J Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limits.

B Laboratory identified compound as not being detected substantially above the level reported in laboratory blanks. Laboratory may be the source of the contamination.

T The mass spectrum does not meet EPA CLP criteria for confirmation, but compound presence is strongly suspected.

TABLE 2-3

ASH DIOXIN RESULTS - SAMPLE ZA-AH-003
FACILITY ZA

PCDD/PCDF Homolog	Ash Sample Result pg/g (ppt)	Toxicity Equivalency Factor(1)	Toxicity Equivalent (ppt)
2,3,7,8-TCDD	10	1.0	10
Other TCDD	206	0.01	2.06
1,2,3,7,8-PeCDD	33	0.5	16.5
Other PeCDD	317	0.005	1.59
1,2,3,4,7,8-H_XCDD	12	0.04	0.48
1,2,3,6,7,8-H_XCDD	17	0.04	0.68
1,2,3,7,8,9-H_XCDD	28	0.04	1.12
Other H_XCDD	154	0.0004	0.062
1,2,3,4,6,7,8-H_PCDD	159	0.001	0.159
Other H_PCDD	140	0.00001	0.0014
OCDD	313	0	0
2,3,7,8-TCDF	263	0.1	26.3
Other TCDF	1,688	0.001	1.69
1,2,3,7,8-PeCDF	61	0.1	6.1
2,3,4,7,8-PeCDF	46	0.1	4.6
Other PeCDF	484	0.001	0.484
1,2,3,4,7,8-H_XCDF	74	0.01	0.74
1,2,3,6,7,8-H_XCDF	131	0.01	1.31
1,2,3,7,8,9-H_XCDF	36	0.01	0.36
2,3,4,6,7,8-H_XCDF	5	0.01	0.05
Other H_XCDF	281	0.0001	0.0281
1,2,3,4,6,7,8-H_PCDF	139	0.001	0.139
1,2,3,4,7,8,9-H_PCDF	8	0.001	0.008
Other H_PCDF	51	0.00001	0.00051
OCDF	66	0	0
Total Toxicity Equivalent			74.5 ppt

(1) Toxicity Equivalency Factors are EPA's current recommended factors (EPA, March 1987).

TABLE 2-4

ASH METALS ANALYSES
FACILITY ZA

Parameter	Samples				
	ZA-AH-001	ZA-AH-002	ZA-AH-003	ZA-AH-004	ZA-AH-005
METALS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Arsenic	50	49	51	45	37
Barium	529	480	554	523	436
Cadmium	43	41	56	32	41
Chromium	93	90	79	64	55
Copper	1,420	7,360	1,160	994	946
Iron	63,300	57,400	48,600	44,100	46,000
Lead	1,580	1,180	1,820	1,480	1,660
Manganese	1,020	835	849	1,360	587
Mercury	10.4	22.9	25.1	16.9	18.0
Selenium	ND	ND	ND	ND	ND
Silver	4.8	5.0	8.7	4.1	7.9
Sodium	10,200	9,970	11,000	9,350	10,400
Zinc	6,900	4,310	6,600	4,740	4,540
METAL OXIDES	(%)	(%)	(%)	(%)	(%)
Aluminum Oxide	8.52	9.37	9.0	9.23	9.85
Calcium Oxide	20.5	20.3	22.2	15.1	18.4
Magnesium Oxide	1.38	1.33	1.31	1.5	1.21
Potassium Monoxide	1.2	1.1	1.24	1.2	1.15
Silicon Dioxide	22.4	22.2	21.9	27.3	43.8

ND Not detected.

TABLE 2-5

ASH CONVENTIONAL ANALYSES
FACILITY ZA

Parameter	Units	Samples				
		ZA-AH-001	ZA-AH-002	ZA-AH-003	ZA-AH-004	ZA-AH-005
pH	S.U.	11.83	11.85	11.79	11.80	11.68
Moisture Content*	%	0.9	1.9	1.6	1.1	1.7
TOC	mg/kg	18,100	22,000	11,400	23,400	35,600
Total Soluble Solids	mg/kg	52,400	49,800	50,400	46,500	48,400
Ammonia	mg/kg	4.47	2.89	5.98	11.5	5.98
Nitrate	mg/kg	2.86	2.29	2.22	2.54	4.23
Ortho Phosphate	mg/kg	ND	ND	ND	ND	ND
Total Alkalinity	mg/kg	7,540	8,000	7,730	8,100	8,050
Chloride	mg/kg	18,300	17,800	23,700	19,100	16,300
Sulfate	mg/kg	5,020	4,800	6,100	4,620	3,770

ND Not detected.
* Determined after samples were prepared.

TABLE 2-6

LEACHATE SEMIVOLATILE ANALYSES
FACILITY ZA

Parameter	Samples (in µg/L)						
	ZA-LE-001	ZA-LE-002	ZA-LE-003	ZA-LE-004	ZA-LE-005	ZA-LE-006	ZA-LE-007
Phenol	ND	19	32	ND	ND	4 J	2 J
3-Methylphenol	ND	ND	6 J	ND	ND	ND	ND
4-Methylphenol	ND	ND	6 J	ND	ND	ND	ND

ND Not Detected.
J Indicates approximate value because contaminants were detected at levels below detection limits, but above the instrument detection limits.

Note: All Samples were collected from Manhole (1):

- ZA-LE-001 was standing liquid sampled on February 11, 1988.
- ZA-LE-002 was sampled on February 11, 1988 immediately after standing liquid was removed.
- ZA-LE-003 was sampled on February 11, 1988 1 hour after standing liquid was removed.
- ZA-LE-004 was sampled on November 29, 1988 immediately after standing liquid was removed.
- ZA-LE-005 was sampled on November 29, 1988 1-1/2 hours after manhole refilled.
- ZA-LE-006 was sampled on June 13, 1989 1 hour after standing liquid was removed.
- ZA-LE-007 was sampled on June 13, 1989 2-1/2 hours after collecting ZA-LE-006.

TABLE 2-7

LEACHATE METALS ANALYSES
FACILITY ZA

Parameter	Samples (in µg/L)							Standards/Criteria (in µg/L)		
	ZA-LE-001	ZA-LE-002	ZA-LE-003	ZA-LE-004	ZA-LE-005	ZA-LE-006	ZA-LE-007	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act(a) MCLs	Safe Drinking Water Act(b) SMCLs
Aluminum	NA	NA	NA	NA	NA	920	700	SNA	SNA	SNA
Arsenic	160	130	140	260	400	47	59	5,000	50	SNA
Barium	NA	NA	NA	NA	NA	ND	ND	100,000	1,000	SNA
Cadmium	ND	1.7	1.1	ND	ND	1.3	1.4	1,000	10	SNA
Calcium	NA	NA	NA	NA	NA	3,270,000	5,360,000	SNA	SNA	SNA
Chromium	8	32	18	16	22	ND	ND	5,000	50	SNA
Copper	ND	ND	ND	ND	ND	ND	ND	SNA	SNA	1,000
Iron	3,400	650	120	2,400	1,600	770	790	SNA	SNA	300
Lead	11	24	25	54	42	18	8	5,000	50	SNA
Magnesium	NA	NA	NA	NA	NA	51,000	70,000	SNA	SNA	SNA
Manganese	4,600	310	370	1,230	800	1,000	2,600	SNA	SNA	50
Mercury	ND	ND	ND	ND	ND	ND	ND	200	2.0	SNA
Nickel	ND	ND	ND	ND	ND	ND	ND	SNA	SNA	SNA
Potassium	NA	NA	NA	NA	NA	525,000	516,000	SNA	SNA	SNA
Selenium	120	120	130	260	340	24	33	1,000	10	SNA
Silicon	NA	NA	NA	NA	NA	2,100	5,700	SNA	SNA	SNA
Silver	ND	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Sodium	NA	NA	NA	NA	NA	3,000,000	3,800,000	SNA	SNA	SNA
Zinc	370	250	190	130	60	250	250	SNA	SNA	5,000

Blank space indicates analysis is below detection limits.

NA	Not analyzed due to differences in scope of work.
ND	Not Detected.
SNA	Standard Not Available.
(a)	Primary Drinking Water Standards
(b)	Secondary Drinking Water Standards.

Note: All Samples were collected from Manhole (1):

- ZA-LE-001 was standing liquid sampled on February 11, 1988
- ZA-LE-002 was sampled on February 11, 1988 immediately after standing liquid was removed.
- ZA-LE-003 was sampled on February 11, 1988 1 hour after standing liquid was removed.
- ZA-LE-004 was sampled on November 29, 1988 immediately after standing liquid was removed.
- ZA-LE-005 was sampled on November 29, 1988 1-1/2 hours after manhole refilled.
- ZA-LE-006 was sampled on June 13, 1989 1 hour after standing liquid was removed.
- ZA-LE-007 was sampled on June 13, 1989 2-1/2 hours after collecting ZA-LE-006.

TABLE 2-8

LEACHATE CONVENTIONAL ANALYSES
FACILITY ZA

Parameter	Samples							Standards/ Criteria
	ZA-LE-001	ZA-LE-002	ZA-LE-003	ZA-LE-004	ZA-LE-005	ZA-LE-006	ZA-LE-007	Primary and Secondary Drinking Water Quality Standards
Ammonia - Distilled (as N)	35 mg/L	23 mg/L	26 mg/L	5.5 mg/L	5.3 mg/L	20 mg/L	28 mg/L	SNA
Organic Carbon	53 mg/L	77 mg/L	110 mg/L	17 mg/L	23 mg/L	25 mg/L	420 mg/L	SNA
Chloride	22,000 mg/L	17,000 mg/L	18,000 mg/L	7,700 mg/L	8,300 mg/L	14,000 mg/L	19,000 mg/L	250 mg/L(b)
Nitrogen, Kjeldahl	43 mg/L	34 mg/L	38 mg/L	NA	NA	NA	NA	SNA
Sulfate (SO_4)	1,000 mg/L	1,500 mg/L	1,500 mg/L	1,000 mg/L	700 mg/L	780 mg/L	620 mg/L	250 mg/L(b)
pH	6.7	6.9	7.2	7.4	6.7	7.2	7.1	SNA
Solids, Dissolved @ 180°C	41,000 mg/L	29,000 mg/L	32,000 mg/L	13,700 mg/L	16,300 mg/L	24,700 mg/L	31,300 mg/L	500 mg/L(b)
Specific Conductance @ 25°C	46,000 μmhos/cm	33,000 μmhos/cm	38,000 μmhos/cm	NA	NA	>10,000 μmhos/cm (field)	>10,000 μmhos/cm (field)	SNA
Total Alkalinity	NA	NA	NA	68 mg/L	44 mg/L	81 mg/L	120 mg/L	SNA
Pht Alkalinity	NA	NA	NA	NA	NA	0	0	SNA
Carbonate Alkalinity	NA	NA	NA	NA	NA	0	0	SNA
Nitrate (as N)	NA	NA	NA	0.2 mg/L	0.2 mg/L	<0.01 mg/L	<0.01 mg/L	10 mg/L(a)
Phosphorus	NA	NA	NA	0.18 mg/L	0.19 mg/L	1.1 mg/L	1.2 mg/L	SNA

NA	Not analyzed due to differences in scope of work.
SNA	Standard Not Available.
(a)	Primary Drinking Water Standards.
(b)	Secondary Drinking Water Standards.

Note: All Samples were collected from Manhole (1):

- ZA-LE-001 was standing liquid sampled on February 11, 1988.
- ZA-LE-002 was sampled on February 11, 1988 immediately after standing liquid was removed.
- ZA-LE-003 was sampled on February 11, 1988 1 hour after standing liquid was removed.
- ZA-LE-004 was sampled on November 29, 1988 immediately after standing liquid was removed.
- ZA-LE-005 was sampled on November 29, 1988 1-1/2 hours after manhole refilled.
- ZA-LE-006 was sampled on June 13, 1989 1 hour after standing liquid was removed.
- ZA-LE-007 was sampled on June 13, 1989 2-1/2 hours after collecting ZA-LE-006.

TABLE 2-9

LEACHATE DIOXIN ANALYSES
FACILITY ZA

Parameter	Samples (ppb)						
	ZA-LE-001	ZA-LE-002	ZA-LE-003	ZA-LE-004	ZA-LE-005	ZA-LE-006	ZA-LE-007
2,3,7,8-TCDD	ND	ND	ND	ND	ND	ND	ND
TCDD-TOT	ND	ND	ND	ND	ND	ND	ND
PeCDD	ND	ND	ND	ND	ND	ND	ND
HXCDD	ND	ND	ND	ND	ND	ND	ND
HPCDD	0.222	ND	ND	ND	ND	ND	ND
OCDD	0.107	0.094	0.057	0.048	0.049	ND	ND
2,3,7,8-TCDF	ND	ND	ND	ND	ND	ND	ND
TCDF-TOT	ND	ND	ND	ND	ND	ND	ND
PeCDF	ND	ND	ND	ND	ND	ND	ND
HXCDF	ND	ND	ND	ND	ND	ND	ND
HPCDF	0.076	ND	ND	ND	ND	ND	ND
OCDF	ND	ND	ND	ND	ND	ND	ND
2,3,7,8-TCDD(1) equivalency ppb	2×10^{-4}	0.00	0.00	0.00	0.00	ND	ND

ND Not Detected.

Note: All Samples were collected from Manhole (1):

- ZA-LE-001 was standing liquid sampled on February 11, 1988.
- ZA-LE-002 was sampled on February 11, 1988 immediately after standing liquid was removed.
- ZA-LE-003 was sampled on February 11, 1988 1 hour after standing liquid was removed.
- ZA-LE-004 was sampled on November 29, 1988 immediately after standing liquid was removed.
- ZA-LE-005 was sampled on November 29, 1988 1-1/2 hours after manhole refilled.
- ZA-LE-006 was sampled on June 13, 1989 1 hour after standing liquid was removed.
- ZA-LE-007 was sampled on June 13, 1989 2-1/2 hours after collecting ZA-LE-006.

(1) 2,3,7,8-TCDD Equivalency calculated using Toxicity Equivalency Factors currently recommended BY EPA (EPA, March 1987).

TABLE 2-10

COMPARISON OF ASH EXTRACTS SEMIVOLATILE ANALYSES
WITH LEACHATE SEMIVOLATILE ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZA

Parameter	Samples (µg/L)	
	Deionized Water Extract	Leachate
Benzoic acid	130	ND
Phenol	ND	ND - 32
3-Methylphenol	ND	ND - 6J
4-Methylphenol	ND	ND - 6J

ND Not detected
J indicates approximate value because contaminants were detected at levels below detection limits, but above the instrument detection limits.

TABLE 2-11

COMPARISON OF ASH EXTRACTS METALS ANALYSES WITH LEACHATE METALS ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZA

Parameter	Samples (in µg/L)							Standards/Criteria (in µg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate[c]	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Arsenic	ND	ND	ND-31	ND	ND	ND	47-400	5,000	50	SNA
Barium	218-282	457-557	177-455	505-651	449-809	464-561	ND	100,000	1,000	SNA
Cadmium	63-108	ND-7.6	592-1,000	ND	ND-695	ND	ND-1.7	1,000	10	SNA
Chromium	ND-5.1	6.8-10	6-72	ND	ND-20	ND-10	ND-32	5,000	50	SNA
Copper	268-620	160-534	790-2,620	104-301	7.6-213	128-610	ND	SNA	SNA	1,000
Iron	40-304	21-115	14-21,700	6.6-46	20-75,400	ND	120-3,400	SNA	SNA	300
Lead	ND-40	1,960-3,410	94-11,300	ND-996	ND-174	1,740-3,940	8-54	5,000	50	SNA
Manganese	1,540-2,390	ND-20	2,450-4,030	ND-4.1	3.8-5,440	ND-2.8	310-4,600	SNA	SNA	50
Mercury	ND-155	ND	23-203	ND-3.8	ND-0.88	ND-0.81	ND	200	2	SNA
Selenium	ND	ND	ND	ND	ND	ND-23	24-340	1,000	10	SNA
Silver	ND-16	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Sodium	108,000-152,000	130,000-174,000	108,000-150,000	1,450,000-1,520,000	71,700-228,000	108,000-160,000	3,000,000-3,800,000	SNA	SNA	SNA
Zinc	22,700-34,400	651-1,340	37,800-75,900	42-377	31-78,500	690-1,290	60-370	SNA	SNA	5,000
Aluminum Oxide	179-302	ND-195	ND-29,300	223-3,100	180-1,850	ND-166	700-920	SNA	SNA	SNA
Calcium Oxide	693,000-699,000	684,000-699,000	2,330,000-3,580,000	669,000-2,380,000	692,000-3,540,000	1,100,000-1,800,000	3,270,000-5,360,000	SNA	SNA	SNA
Magnesium Oxide	32,000-42,800	50-379	27,300-58,900	74-400	623-66,900	12-18	51,000-70,000	SNA	SNA	SNA
Potassium Monoxide	114,000-143,000	134,000-168,000	10,100-154,000	143,000-210,000	63,300-224,000	118,000-168,000	516,000-525,000	SNA	SNA	SNA
Silicon Dioxide	36,600-71,800	616-1,640	29,000-98,700	2,790-5,520	1,360-81,100	364-877	2,100-5,700	SNA	SNA	SNA

ND Not Detected.
SNA Standard Not Available.

(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.
(c) Results for aluminum, calcium, magnesium, potassium, and silicon are for metals and not oxides.

TABLE 2-12

COMPARISON OF ASH EXTRACTS CONVENTIONAL ANALYSES WITH LEACHATE CONVENTIONAL ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZA

Parameter	Samples (in mg/L)							Standards/Criteria (in mg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[(a)] MCLs	Safe Drinking Water Act[(b)] SMCLs
Ammonia-Distilled (as N)	0.21-0.44	0.21-0.28	0.27-0.45	0.22-0.38	ND-0.28	0.89-1.03	5.3-35	SNA	SNA	SNA
Total Organic Carbon	23.9-64.2	15.3-43.5	2,210-2,520	2,040-2,340	2,200-2,400	12.8-42.5	17-420	SNA	SNA	SNA
Chloride	773-1,040	802-1,170	748-1,160	971-1,250	686-1,410	840-1,200	7,700-22,000	SNA	SNA	250
Sulfate	832-1,050	429-603	917-1,320	489-567	617-1,110	507-627	620-1,500	SNA	SNA	250
Solids, Dissolved @ 180°C	3,920-4,890	2,890-4,220	8,090-11,800	8,820-10,700	9,230-11,100	2,970-4,420	13,700-41,000	SNA	SNA	500
Total Alkalinity	1,240-1,630	908-1,590	1,250-2,630	2,390-3,060	2,130-3,350	856-1,710	44-120	SNA	SNA	SNA
Nitrate (as N)	0.13-0.30	0.12-0.20	0.11-0.21	0.13-0.18	0.07-0.16	3.04-3.25	ND-0.2	SNA	10	SNA
Orthophosphate	ND-0.09	ND	ND-0.94	ND	ND	ND	0.18-1.2	SNA	SNA	SNA
Extract's Initial pH	6.15-6.25	12.29-12.48	12.08-12.31	12.08-12.31	12.09-12.27	12.08-12.27	NA	SNA	SNA	SNA
Extract's Final pH	12.25-12.48	12.24-12.47	5.03-6.97	11.23-12.04	5.87-11.12	12.05-12.24	NA	SNA	SNA	SNA

NA Not analyzed due to differences in scope of work.
ND Not Detected.
SNA Standard Not Available
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

3

3.0 FACILITY ZB FINDINGS

3.1 FACILITY ZB DESCRIPTION

Facility ZB consists of two mass-burn, water-wall boilers. Refuse is charged into the boilers by front-end loaders, moves inside the boilers on grates, and is discharged into an ash quench tank located below the boilers. Dry lime is added to the flue gas where it is mixed with the fly ash. This mixture is then collected in baghouses and mixed with the bottom ash for disposal. The steam generated at the facility is used to generate electricity, which is sold to a local utility. The following details outline the operational information for this facility.

Startup Date	Early 1987.
Refuse Feed Rate:	75-100 tons/day/boiler.
Operating Temperature:	1,800° F.
Residence Time:	Approximately 1/2 to 3/4 hour in the boiler, where the grates can be slowed to allow wet loads more time to dry out; approximately 20 minutes from ash quench to ash pile.
Backup Fuel:	Propane -- is used during start ups and shut downs.
Air Feed Information:	Underfire air comes directly from the tipping floor and is not preheated unless trash is very wet. Overfire air comes from inside the boiler room and is not preheated except by the heat buildup in the building.
Air Feed Rate:	Primary Air - 10,890 cubic feet/minute Secondary Air - 5,900 cubic feet/minute
Grate Information:	There are four zones on the grates: Drying Zone, Burn Zone, Burn Down Zone, Cool Down Zone. The speed of each zone can be maintained separately.
Refuse Feed Method:	Refuse is dumped on the tipping floor, where new refuse is mixed with old refuse with a front-end loader. The front-end loader can only mix waste near the working face of the pile. If the piles are large (normal condition), the front-end loader

cannot effectively mix the refuse located on the bottom of the pile away from the working face. The front-end loader is also used to load the trash into the feed hoppers. NUS personnel also observed several trucks backing right up to the feed hoppers and dumping the loads directly into the feed hoppers or right in front of the hoppers. These loads were fired directly into the boiler without any mixing.

Trash Accepted: Residential (80%), commercial, and light industrial (20%) waste generated in the surrounding communities. No sewage sludge is accepted.

Normal Moisture Content of Ash: (As measured by the facility.) 36-37 percent.

Source of Ash Quench Water: Ash Quench Water consists of water used to rinse the ash bins; water draining from the ash; septic system discharge; and blowdowns from cooling tower and boiler.

Electricity Generated: 4.5 Megawatts/hour.

Electricity Used by Facility: 0.6 Megawatts/hour.

Ash-Handling Equipment

The bottom ash is discharged into one of two quench tanks that are equipped with drag flight conveyors. The ash settles to the bottom of the quench tank and is moved along by the drag flights. It then travels up an incline and is dumped into ash bins (roll-off containers).

Dry lime is injected into the flue gas to neutralize any acidic gases. The lime-fly ash mixture is collected in baghouses and transported back into the main building. Phosphoric acid and water are mixed with the lime-fly ash mixture. The resulting mixture is agglomerated and is then added to the bottom ash as the bottom ash travels up the incline and before it is dumped into the ash bins.

The mixed ash is deposited in the ash bins in two piles. As the first pile reaches the top of the bin, the ash conveyor is shut down so that the bin can be moved to start the second pile. Once the bins are full, the ash conveyor is again shut down so that the bins can be switched. The bins are transported daily to the ash disposal facility.

The ash bins are equipped with drains so that some of the free moisture in the ash can drain off. When the ash bins are switched, the drains on the full bins are capped, the outside of the bin is washed off, and the full bin is moved into the yard. Once in the yard, the ash is leveled off and covered with tarps. The ash conveyor is restarted when the empty bin is in place and the caps on the drains are removed. This process can take anywhere from 10 to 30 minutes. The fly ash is continually discharged onto the incline of the drag conveyor during the changing of the ash bins.

The ash samples at Facility ZB were collected as the ash traveled up the inclined portion of the drag conveyor, just after the fly ash was mixed with the bottom ash. Each partial sample was collected from 1, 2, or 3 different flights, depending on the quantity of ash present on the flights.

3.2 CHEMICAL CHARACTERIZATION OF ASH

Table 3-1 presents the results of the semivolatile analysis of the ash samples from Facility ZB. The results in this table indicate that bis(2-ethylhexyl)phthalate was detected in sample ZB-AH-001, the only sample from this facility analyzed for the Appendix IX semivolatiles. This compound appears to be the result of laboratory contamination.

Table 3-2 presents the results of the polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD/PCDF) analyses of sample ZB-AH-001. Toxicity equivalency values were calculated according to EPA's methodology (EPA, March 1987) and are presented in this table. The data in this table indicate that the PCDDs/PCDFs levels found in the ash are substantially below the Centers for Disease Control (CDC) recommended upper level of 2,3,7,8-TCDD toxicity equivalency of 1 part per billion in residential soil (Kimbrough, 1984).

The results of the metals analyses for the ash from this facility are presented in Table 3-3. The data in this table indicate that, except for barium, cadmium, copper, and zinc, the results were fairly constant during the week of sampling.

The results for the conventional analyses are presented in Table 3-4. The data in this table indicate that, except for TOC, ammonia, chloride, sulfate, and total alkalinity, the results were also fairly constant during the week.

3.3 CHEMICAL CHARACTERIZATION OF LEACHATES

The facility used for the disposal of ash from MWC Facility ZB is lined and is used exclusively for the disposal of ash from Facility ZB.

The leachate sample (ZB-LE-001) from the ash disposal facility for MWC Facility ZB was a grab sample collected from a valve on the main leachate collection line. A second sample (ZB-LE-002) was collected from the leak detection system located under the primary liner.

No Appendix IX semivolatile compounds or PCDDs/PCDFs were detected in the leachate sample from the ash disposal facility for MWC Facility ZB, or in the sample from the leak detection system.

The results for the metals analysis of the leachate sample are shown in Table 3-5. The data in this table indicate that none of the compounds exceeded the EP Toxicity Maximum Allowable Limit. Although the leachate is not required to meet Drinking Water Standards, a comparison of the leachate results with the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988) was made. This comparison indicates that the majority of the metals results met these standards in the leachate.

Table 3-6 presents the results of the conventional analyses of the leachate sample (ZB-LE-001). The TDS value was 40,600 mg/L and the pH of the leachate was 6.5.

The results for the metals analysis of the sample from the leak detection system (ZB-LE-002) are shown in Table 3-7. The data in this table indicate that none of the compounds exceeded the EP Toxicity Maximum Allowable Limit. Although this water is not required to meet Drinking Water Standards, a comparison of the results with the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988) was made. This comparison indicates that the results for all metals met these standards in the sample from the leak detection system.

Table 3-8 presents the results of the conventional analyses of the samples from the leak detection system. The TDS value was 535 mg/L and the pH of the sample was 6.5.

The data in both Tables 3-7 and 3-8 indicate that the liner is intact and no leachate is entering the leak detection system.

3.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS

No Appendix IX semivolatile compounds or PCDDs/PCDFs were detected in the composite sample from the deionized water extracts (SW-924) of the ash from MWC Facility ZB.

Table 3-9 presents the range of results of the metals analyses of the ash extracts from MWC Facility ZB and the results for the leachate sample from the ash fill serving this facility. For comparison, this table also lists the EP Toxicity Maximum Allowable Limits, and the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988).

The results presented in Table 3-9 indicate that the extracts from the EP toxicity, the TCLP 1, and the TCLP 2 extraction techniques generally contain higher concentrations of metals than the extracts produced by the other extraction techniques. The data in this table also indicate that the extracts from the CO_2 extraction technique generally contain lower concentrations of metals than the extracts produced by the other extraction techniques.

For this facility, none of the extracts exceeded the EP Toxicity Maximum Allowable Limits established in Section 261.24 of 40 CFR 261.

Although the ash extracts would not be required to meet Drinking Water Standards, a comparison of the ash extract results with the Drinking Water Standards was made. This comparison indicates that the majority of the metals results met these standards.

Table 3-10 presents the range of results of the conventional analyses of the ash extracts from MWC Facility ZB and the leachate sample from the ash fill serving this facility. For comparison, this table also lists the Primary Drinking Water standards for nitrate, as well as the Secondary Drinking Water Standards for chloride, sulfate, and Total Dissolved Solids (TDS). The data in this table indicate that the results for the conventional compounds from the CO_2 extraction technique are generally lower than the results from the other extraction techniques.

TABLE 3-1

ASH SEMIVOLATILE RESULTS - SAMPLE ZB-AH-001
FACILITY ZB

Parameter	Ash Sample Result (µg/kg)
Bis(2-ethylhexyl)phthalate	810JB

J Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limit.

B Laboratory identified compound as not being detected substantially above the level reported in laboratory blanks. Laboratory may be the source of the compound.

TABLE 3-2

ASH DIOXIN RESULTS - SAMPLE ZB-AH-001
FACILITY ZB

PCDD/PCDF Homolog	Ash Sample Result pg/g (ppt)	Toxicity Equivalency Factor(1)	Toxicity Equivalent (ppt)
2,3,7,8-TCDD	24	1.0	24
Other TCDD	351	0.01	3.51
1,2,3,7,8-PeCDD	118	0.5	59
Other PeCDD	759	0.005	3.80
1,2,3,4,7,8-H_XCDD	40	0.04	1.6
1,2,3,6,7,8-H_XCDD	34	0.04	1.36
1,2,3,7,8,9-H_XCDD	79	0.04	3.16
Other H_XCDD	342	0.0004	0.137
1,2,3,4,6,7,8-H_PCDD	319	0.001	0.319
Other H_PCDD	288	0.00001	0.00288
OCDD	544	0	0
2,3,7,8-TCDF	617	0.1	61.7
Other TCDF	3,721	0.001	3.72
1,2,3,7,8-PeCDF	194	0.1	19.4
2,3,4,7,8-PeCDF	162	0.1	16.2
Other PeCDF	1,527	0.001	1.53
1,2,3,4,7,8-H_XCDF	336	0.01	3.36
1,2,3,6,7,8-H_XCDF	524	0.01	5.24
1,2,3,7,8,9-H_XCDF	127	0.01	1.27
2,3,4,6,7,8-H_XCDF	54	0.01	0.54
Other H_XCDF	939	0.0001	0.0939
1,2,3,4,6,7,8-H_PCDF	539	0.001	0.539
1,2,3,4,7,8,9-H_PCDF	48	0.001	0.048
Other H_PCDF	197	0.00001	0.00197
OCDF	243	0	0
Total Toxicity Equivalent			211 ppt

(1) Toxicity Equivalency Factors are EPA's current recommended factors (EPA, March 1987).

TABLE 3-3

ASH METALS ANALYSES
FACILITY ZB

Parameter	Samples				
	ZB-AH-001	ZB-AH-002	ZB-AH-003	ZB-AH-004	ZB-AH-005
METALS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Arsenic	28	45	31	56	54
Barium	484	322	1,000	260	283
Cadmium	52	152	64	57	58
Chromium	53	74	67	118	65
Copper	9,330	1,370	674	842	4,440
Iron	18,800	19,300	13,600	21,500	22,200
Lead	1,070	1,630	1,490	1,420	1,740
Manganese	508	559	622	846	515
Mercury	8.2	11	7.7	8.0	12
Selenium	5.7	ND	ND	ND	ND
Silver	6.9	9.4	6.0	10	5.4
Sodium	8,200	9,210	8,940	9,810	10,600
Zinc	8,580	6,480	4,360	15,800	6,450
METAL OXIDES	(%)	(%)	(%)	(%)	(%)
Aluminum Oxide	8.46	10.3	9.35	9.26	7.39
Calcium Oxide	19.4	22.3	21.2	20.6	25.7
Magnesium Oxide	1.40	1.62	1.45	1.54	1.19
Potassium Monoxide	0.941	0.827	0.938	0.912	0.866
Silicon Dioxide	28.9	22.1	29.4	28.2	19.0

ND Not detected.

TABLE 3-4

ASH CONVENTIONAL ANALYSES
FACILITY ZB

Parameter	Units	Samples				
		ZB-AH-001	ZB-AH-002	ZB-AH-003	ZB-AH-004	ZB-AH-005
pH	S.U.	11.48	10.91	11.49	11.59	11.67
Moisture Content*	%	4.5	5.1	2.7	3.8	8.8
TOC	mg/kg	14,600	29,600	22,800	29,400	17,000
Total Soluble Solids	mg/kg	36,700	65,800	44,000	45,300	55,300
Ammonia	mg/kg	3.69	10.6	3.93	4.85	4.76
Nitrate	mg/kg	2.65	2.75	1.45	2.09	2.87
Orthophosphate	mg/kg	ND	ND	ND	ND	ND
Total Alkalinity	mg/kg	4,520	1,590	5,150	6,650	6,320
Chloride	mg/kg	18,600	44,200	19,500	28,000	31,400
Sulfate	mg/kg	963	764	3,130	2,440	1,340

ND Not detected.
* Determined after samples were prepared.

TABLE 3-5

LEACHATE METALS ANALYSES
FACILITY ZB

Parameter	Sample (µg/L)	Standards/Criteria (µg/L)		
	ZB-LE-001	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[(a)] MCLs	Safe Drinking Water Act[(b)] SMCLs
Aluminum	ND	SNA	SNA	SNA
Arsenic	ND	5,000	50	SNA
Barium	9,220	100,000	1,000	SNA
Cadmium	4.0	1,000	10	SNA
Calcium	8,390,000	SNA	SNA	SNA
Chromium	ND	5,000	50	SNA
Copper	8.8	SNA	SNA	1,000
Iron	840	SNA	SNA	300
Lead	ND	5,000	50	SNA
Magnesium	17,300	SNA	SNA	SNA
Manganese	17,600	SNA	SNA	50
Mercury	ND	200	2.0	SNA
Potassium	1,620,000	SNA	SNA	SNA
Selenium	ND	1,000	10	SNA
Silicon	3,150	SNA	SNA	SNA
Silver	ND	5,000	50	SNA
Sodium	2,450,000	SNA	SNA	SNA
Zinc	8.3	SNA	SNA	5,000

ND Not detected.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 3-6

LEACHATE CONVENTIONAL ANALYSES
FACILITY ZB

Parameter	Sample	Standards/Criteria
	ZB-LE-001	Primary and Secondary Drinking Water Quality Standards
Ammonia-Distilled (as N)	4.18 mg/L	SNA
Organic Carbon	30 mg/L	SNA
Temperature (field)	9°C	SNA
Sulfate (SO_4)	171 mg/L	250 mg/L(b)
pH (field)	6.5	SNA
Solids, Dissolved @ 180°C	40,600 mg/L	500 mg/L(b)
Specific Conductance @ 25°C (field)	>10,000 µmhos/cm	SNA
Total Alkalinity	65 mg/L	SNA
Nitrate (as N)	0.45 mg/L	10 mg/L(a)
Orthophosphate	0.01 mg/L	SNA

SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 3-7

LEAK DETECTION SYSTEM SAMPLE METALS ANALYSES
FACILITY ZB

Parameter	Sample (µg/L)	Standards/Criteria (µg/L)		
	ZB-LE-002	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Aluminum	19	SNA	SNA	SNA
Arsenic	ND	5,000	50	SNA
Barium	64	100,000	1,000	SNA
Cadmium	ND	1,000	10	SNA
Calcium	112,000	SNA	SNA	SNA
Chromium	ND	5,000	50	SNA
Copper	5.4	SNA	SNA	1,000
Iron	ND	SNA	SNA	300
Lead	ND	5,000	50	SNA
Magnesium	15,700	SNA	SNA	SNA
Manganese	6.7	SNA	SNA	50
Mercury	ND	200	2.0	SNA
Potassium	10,900	SNA	SNA	SNA
Selenium	ND	1,000	10	SNA
Silicon	3,590	SNA	SNA	SNA
Silver	ND	5,000	50	SNA
Sodium	14,000	SNA	SNA	SNA
Zinc	7.5	SNA	SNA	5,000

ND Not detected.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 3-8

LEAK DETECTION SYSTEM SAMPLE CONVENTIONAL ANALYSES
FACILITY ZB

Parameter	Sample	Standards/Criteria
	ZB-LE-002	Primary and Secondary Drinking Water Quality Standards
Ammonia-Distilled (as N)	<0.05 mg/L	SNA
Organic Carbon	10.6 mg/L	SNA
Temperature (field)	5°C	SNA
Sulfate (SO_4)	197 mg/L	250 mg/L[(b)]
pH (field)	6.5	SNA
Solids, Dissolved @ 180°C	535 mg/L	500 mg/L[(b)]
Specific Conductance @ 25°C (field)	880 µmhos/cm	SNA
Total Alkalinity	154 mg/L	SNA
Nitrate (as N)	0.01 mg/L	10 mg/L[(a)]
Orthophosphate	<0.01 mg/L	SNA

SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 3-9

COMPARISON OF ASH EXTRACTS METALS ANALYSES WITH LEACHATE METALS ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZB

Parameter	Samples (in µg/L)							Standards/Criteria (in µg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate(c)	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act(a) MCLs	Safe Drinking Water Act(b) SMCLs
Arsenic	ND-53	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Barium	126-381	454-3,050	182-350	498-1,850	321-511	1,150-3,960	9,220	100,000	1,000	SNA
Cadmium	ND-9.2	ND	25-485	ND	ND-833	ND	4.0	1,000	10	SNA
Chromium	ND	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Copper	8.8-30	18-35	25-803	10-36	5.4-262	21-64	8.8	SNA	SNA	1,000
Iron	ND	ND	ND	ND	ND-3,360	ND	840	SNA	SNA	300
Lead	ND	ND-731	ND-19	ND	ND	ND-293	ND	5,000	50	SNA
Manganese	ND-11	ND	250-1,790	ND-5.8	39-2,250	ND	17,600	SNA	SNA	50
Mercury	ND	ND	0.73-9.8	ND-0.25	0.37-4.6	ND	ND	200	2	SNA
Selenium	ND	ND	ND	ND	ND	ND	ND	1,000	10	SNA
Silver	ND	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Sodium	114,000-168,000	123,000-209,000	128,000-225,000	1,410,000-1,450,000	116,000-183,000	117,000-201,000	2,450,000	SNA	SNA	SNA
Zinc	5-21	40-349	67-9,630	9.7-49	26-10,000	20-287	8.3	SNA	SNA	5,000
Aluminum Oxide	4,990-90,700	161-48,400	ND-100	1,410-62,800	ND-7,760	102-102,000	ND	SNA	SNA	SNA
Calcium Oxide	737,000-1,920,000	810,000-1,740,000	3,240,000-4,810,000	1,810,000-2,750,000	3,210,000-3,640,000	699,000-1,690,000	8,390,000	SNA	SNA	SNA
Magnesium Oxide	207-24,600	21-68	70,400-130,000	55-920	12,400-137,000	17-65	17,300	SNA	SNA	SNA
Potassium Monoxide	99,200-155,000	108,000-189,000	101,000-189,000	122,000-203,000	100,000-167,000	114,000-181,000	1,620,000	SNA	SNA	SNA
Silicon Dioxide	418-1,280	406-2,300	5,090-32,900	379-3,560	820-79,000	544-2,330	3,150	SNA	SNA	SNA

ND Not Detected.
SNA Standard Not Available.

(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.
(c) Results for aluminum, calcium, magnesium, potassium, and silicon are for metals and not oxides.

TABLE 3-10

COMPARISON OF ASH EXTRACTS CONVENTIONAL ANALYSES WITH LEACHATE CONVENTIONAL ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZB

Parameter	Samples (in mg/L)							Standards/Criteria (in mg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act(a) MCLs	Safe Drinking Water Act(b) SMCLs
Ammonia-Distilled (as N)	NA	0.10-0.28	NA	NA	NA	NA	4.18	SNA	SNA	SNA
Total Organic Carbon	NA	3.37-6.52	NA	NA	NA	4.52-11.5	30.0	SNA	SNA	SNA
Chloride	1,080-2,930	1,070-3,040	1,020-3,440	1,340-3,500	1,270-2,720	NA	NA	SNA	SNA	250
Sulfate	22.9-662	ND-119	556-950	4.4-524	674-1,110	NA	171	SNA	SNA	250
Solids, Dissolved @ 180°C	NA	2,180-4,310	NA	NA	NA	NA	40,600	SNA	SNA	500
Total Alkalinity	NA	285-996	NA	NA	NA	NA	65	SNA	SNA	SNA
Nitrate (as N)	0.14-0.36	0.11-0.24	0.13-0.34	0.13-0.31	0.07-0.30	NA	0.45	SNA	10	SNA
Orthophosphate	ND-0.01	ND	0.06-1.32	ND-0.01	0.01-1.75	ND	ND-0.01	SNA	SNA	SNA
Extract's Initial pH	5.51-5.84	11.78-12.24	11.83-12.30	11.78-12.24	11.78-12.24	11.45-12.01	NA	SNA	SNA	SNA
Extract's Final pH	9.39-10.61	11.12-12.48	5.77-8.64	10.40-11.83	6.23-9.53	10.83-12.42	NA	SNA	SNA	SNA

NA Not analyzed due to differences in scope of work.
ND Not Detected.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

4

4.0 FACILITY ZC FINDINGS

4.1 FACILITY ZC DESCRIPTION

Facility ZC consists of three mass-burn, water-wall boilers. Refuse is charged into the boilers by overhead cranes, moves inside the boilers on grates, and is discharged into ash quench units on the bottom of the boilers. Fly ash in the exhaust gas is collected and mixed with the bottom ash for disposal. The steam generated at the facility is used to generate electricity, which is sold to a local utility. The following details provide operational information for this facility.

Startup Date:	January 1987.
Refuse Feed Rate:	400 tons/day/boiler.
Operating Temperature:	1,750-1,800° F.
Residence Time:	Approximately 1-1/2 hours in boiler, where the grates can be slowed to allow wet loads more time to dry out.
Backup Fuel:	Natural gas - has only been used at start ups and shut downs.
Air Temperature Into Furnace:	Underfire air 380° F; overfire air not heated.
Air Feed Rate:	Varies--underfire air 40,000 cfm; overfire air 6,000 cfm.
Refuse Feed Method:	Old and new refuse is mixed with an overhead crane. Mixed refuse is loaded into boilers with the overhead crane. Not much mixing was observed by NUS personnel.
Trash Accepted:	Any residential, commercial, or industrial waste generated in the local community. No sewage sludge is accepted. Some waste oil is disposed of at the facility.
Source of Ash Quench Water:	Ash quench water consists of effluent from a local sewage treatment plant.
Electricity Generated:	29 Megawatts/hour.
Electricity Used by Facility:	2-1/2 Megawatts/hour.

Ash-Handling Equipment

The flue gas passes through electrostatic precipitators (ESPs), where the fly ash is removed from the flue gases. The fly ash is then transported back to ash quench reactors located at the bottom of each boiler, where it is mixed with the bottom ash.

The fly ash is mixed with the bottom ash in the ash quench reactors. From there, the ash mixture is discharged onto a large shaker conveyor. It travels to a grizzly, where large items are removed, is discharged onto a small shaker or pan conveyor, and is then discharged onto an inclined conveyor belt. The ferrous material is removed at the top of the conveyor belt by a rotating electromagnet. The ash falls from the inclined belt onto a final shaker conveyor and then falls through one of two chutes onto the ash pile. The ash is loaded onto trucks for transportation to the ash fill. The ferrous material is recycled after passing through a trommel, where small particles of ash clinging to the metal are removed.

The ash samples at Facility ZC were collected from the final shaker conveyor after the ferrous material was removed and before the ash passed through the chutes onto the ash pile. The ash had a tendency to segregate itself at the top of the inclined conveyor belt. The large particles came directly from the inclined conveyor and onto the shaker conveyor, whereas the finer, wetter particles stuck to the belt and started back down on the underside of the inclined conveyor. These finer particles were scraped off the underside of the belt about 6 feet from the top of the conveyor. Ash samples were collected both from the shaker conveyor and as the ash was scraped off the bottom of the inclined conveyor.

During the first part of one day's sampling, the samples were collected as the ash came off the grizzly because the inclined conveyor was shut down for repairs. In addition, the location of the sampling point on the final shaker conveyor changed as the facility changed the chutes being used to deposit the ash on the ash pile.

4.2 CHEMICAL CHARACTERIZATION OF ASH

Table 4-1 presents the results of the semivolatile analysis of the ash samples from Facility ZC. The data in this table indicate that bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were detected in sample ZC-AH-003, the only sample from this facility analyzed for the Appendix IX semivolatiles. These compounds appear to be the result of laboratory contamination.

Table 4-2 presents the results of the polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD/PCDF) analyses of sample ZC-AH-003. Toxicity equivalency values were calculated according to EPA's methodology (EPA, March 1987) and are presented in this table. The data in this table indicate that the PCDDs/PCDFs levels found in the ash are substantially below the Centers for Disease Control (CDC) recommended upper level of 2,3,7,8-TCDD toxicity equivalency of 1 part per billion in residential soil (Kimbrough, 1984).

The results of the metals analyses for the ash from this facility are presented in Table 4-3. The data in this table indicate that, except for copper and manganese, the results were fairly constant during the week of sampling.

The results for the conventional analyses are presented in Table 4-4. The data in this table indicate that, except for nitrate, and total alkalinity, the results were also fairly constant during the week.

4.3 CHEMICAL CHARACTERIZATION OF LEACHATES

The facility used for the disposal of ash from MWC Facility ZC is lined and is also used for the disposal of ash from a different MWC facility. In addition, municipal waste in excess of the capacity of the MWC facilities is disposed of at this ash disposal facility. Of the ash disposed of at this facility, two-thirds of it comes from MWC Facility ZC. The two leachate samples from the ash disposal facility for MWC Facility ZC were two grab samples collected from the same leachate collection sump.

No Appendix IX semivolatile compounds or PCDDs/PCDFs were detected in the leachate samples from the ash disposal facility for MWC Facility ZC.

The results for the metals analysis of the leachate samples are shown in Table 4-5. The data in this table indicate that none of the compounds exceeded the EP Toxicity Maximum Allowable Limit. Although the leachates are not required to meet Drinking Water Standards, a comparison of the leachate results with the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act

(EPA: BNA, June 1989 and EPA: BNA, October 1988) was made. This comparison indicates that the results for all but manganese met these standards in the leachate.

Table 4-6 presents the results of the conventional analyses of the leachate samples. TDS values ranged from 924 mg/L to 932 mg/L, and the pH of the leachate was 6.9.

4.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS

No Appendix IX semivolatile compounds or PCDDs/PCDFs were detected in the composite sample from the deionized water extracts (SW-924) of the ash from MWC Facility ZC.

Table 4-7 presents the range of results of the metals analyses of the ash extracts from MWC Facility ZC and the range of results for the leachate samples for the ash fill serving this facility. For comparison, this table also lists the EP Toxicity Maximum Allowable Limits, and the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988).

The results presented in Table 4-7 indicate that the extracts from the EP Toxicity, the TCLP 1, and the TCLP 2 extraction techniques generally contain higher metal concentrations than the extracts produced by the other extraction techniques. The data in this table also indicate that the extracts from the deionized water extraction technique (SW-924) and the SAR extraction technique generally contain lower metal concentrations than the extracts produced by the other extraction techniques.

For this facility, the extracts from the EP Toxicity, as well as the TCLP 2 extraction techniques, exceeded the EP Toxicity Maximum Allowable Limits established in Section 261.24 of 40 CFR 261 for cadmium and lead, whereas the extracts from the TCLP 1 extraction technique exceeded the EP Toxicity Maximum Allowable Limits only for cadmium.

Although the ash extracts would not be required to meet Drinking Water Standards, a comparison of the ash extract results with the Drinking Water Standards was made. This comparison indicates that the majority of the metals results met these standards.

Table 4-8 presents the range of results of the conventional analyses of the ash extracts from MWC Facility ZC and the range of results for the leachate samples from the ash fill serving this facility. For comparison, this table also lists the Primary Drinking Water Standards for nitrate, as well as the Secondary Drinking Water Standards for chloride, sulfate, and Total Dissolved Solids (TDS).

TABLE 4-1

ASH SEMIVOLATILE RESULTS - SAMPLE ZC-AH-003
FACILITY ZC

Parameter	Ash Sample Result (µg/kg)
Bis(2-ethylhexyl)phthalate	310JB
Di-n-butyl phthalate	400JB

J	Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limits.
B	Laboratory identified compound as not being detected substantially above the level reported in laboratory blanks. Laboratory may be the source of the compound.

TABLE 4-2

ASH DIOXIN RESULTS - SAMPLE ZC-AH-003
FACILITY ZC

PCDD/PCDF Homolog	Ash Sample Result pg/g (ppt)	Toxicity Equivalency Factor(1)	Toxicity Equivalent (ppt)
2,3,7,8-TCDD	16	1.0	16
Other TCDD	281	0.01	2.81
1,2,3,7,8-PeCDD	71	0.5	35.5
Other PeCDD	1,051	0.005	5.26
1,2,3,4,7,8-H_XCDD	66	0.04	2.64
1,2,3,6,7,8-H_XCDD	90	0.04	3.6
1,2,3,7,8,9-H_XCDD	120	0.04	4.8
Other H_XCDD	925	0.0004	0.37
1,2,3,4,6,7,8-H_PCDD	1,849	0.001	1.85
Other H_PCDD	1,511	0.00001	0.0151
OCDD	6,906	0	0
2,3,7,8-TCDF	236	0.1	23.6
Other TCDF	1,208	0.001	1.21
1,2,3,7,8-PeCDF	64	0.1	6.4
2,3,4,7,8-PeCDF	56	0.1	5.6
Other PeCDF	607	0.001	0.607
1,2,3,4,7,8-H_XCDF	218	0.01	2.18
1,2,3,6,7,8-H_XCDF	279	0.01	2.79
1,2,3,7,8,9-H_XCDF	193	0.01	1.93
2,3,4,6,7,8-H_XCDF	70	0.01	0.70
Other H_XCDF	635	0.0001	0.0635
1,2,3,4,6,7,8-H_PCDF	653	0.001	0.653
1,2,3,4,7,8,9-H_PCDF	83	0.001	0.083
Other H_PCDF	254	0.00001	0.00254
OCDF	563	0	0
Total Toxicity Equivalent			119 ppt

(1) Toxicity Equivalency Factors are EPA's current recommended factors, (EPA, March 1987).

TABLE 4-3

ASH METALS ANALYSES
FACILITY ZC

Parameter	Samples				
	ZC-AH-001	ZC-AH-002	ZC-AH-003	ZC-AH-004	ZC-AH-005
METALS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Arsenic	31	36	30	28	29
Barium	213	193	248	314	331
Cadmium	42	49	52	47	48
Chromium	51	53	57	45	48
Copper	1,[illegible]50	524	4,470	758	547
Iron	21,300	20,000	23,500	22,100	25,000
Lead	2,380	2,580	1,760	2,630	1,710
Manganese	1,200	826	898	565	518
Mercury	1.8	1.1	2.3	3.2	1.7
Selenium	ND	ND	ND	ND	ND
Silver	8.8	12	5.8	5.6	6.0
Sodium	8,630	8,940	7,940	8,040	7,370
Zinc	4,660	7,170	4,390	4,180	4,110
METAL OXIDES	(%)	(%)	(%)	(%)	(%)
Aluminum Oxide	8.64	7.98	6.67	6.65	5.93
Calcium Oxide	9.7	11.4	10.8	10.3	10.6
Magnesium Oxide	1.02	1.17	1.3	1.08	1.11
Potassium Monoxide	0.875	1.07	1.04	1.03	0.992
Silicon Dioxide	62.9	53.8	48.4	57.0	49.5

ND Not detected.

TABLE 4-4

ASH CONVENTIONAL ANALYSES
FACILITY ZC

Parameter	Units	Samples				
		ZC-AH-001	ZC-AH-002	ZC-AH-003	ZC-AH-004	ZC-AH-005
pH	S.U.	11.75	11.82	11.58	11.82	11.74
Moisture Content*	%	1.0	1.5	2.0	0.6	1.4
TOC	mg/kg	9,020	12,300	14,100	9,830	17,800
Total Soluble Solids	mg/kg	24,600	22,000	23,600	23,000	26,100
Ammonia	mg/kg	1.49	1.86	1.40	1.33	2.10
Nitrate	mg/kg	6.46	0.11	0.09	0.14	0.28
Orthophosphate	mg/kg	ND	ND	ND	ND	ND
Total Alkalinity	mg/kg	2,690	2,970	1,210	2,840	3,040
Chloride	mg/kg	5,180	3,870	4,180	5,860	5,280
Sulfate	mg/kg	7,870	5,900	7,400	9,060	10,300

ND Not detected.

*Determined after samples were prepared.

TABLE 4-5

LEACHATE METALS ANALYSES
FACILITY ZC

Parameter	Samples (µg/L)		Standards/Criteria (µg/L)		
	ZC-LE-001	ZC-LE-002	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Aluminum	ND	ND	SNA	SNA	SNA
Arsenic	ND	ND	5,000	50	SNA
Barium	7.8	8.0	100,000	1,000	SNA
Cadmium	ND	ND	1,000	10	SNA
Calcium	64,600	65,800	SNA	SNA	SNA
Chromium	ND	ND	5,000	50	SNA
Copper	ND	ND	SNA	SNA	1,000
Iron	108	115	SNA	SNA	300
Lead	ND	34	5,000	50	SNA
Magnesium	22,600	23,000	SNA	SNA	SNA
Manganese	493	501	SNA	SNA	50
Mercury	ND	ND	200	2.0	SNA
Potassium	79,700	81,200	SNA	SNA	SNA
Selenium	ND	ND	1,000	10	SNA
Silicon	4,570	4,840	SNA	SNA	SNA
Silver	ND	ND	5,000	50	SNA
Sodium	188,000	191,000	SNA	SNA	SNA
Zinc	13	9.0	SNA	SNA	5,000

ND Not detected.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 4-6

LEACHATE CONVENTIONAL ANALYSES
FACILITY ZC

Parameter	Samples		Standards/Criteria
	ZC-LE-001	ZC-LE-002	Primary and Secondary Drinking Water Quality Standards
Ammonia-Distilled (as N)	68.2 mg/L	77.4 mg/L	SNA
Organic Carbon	47.2 mg/L	49.3 mg/L	SNA
Temperature (field)	21°C	NA	SNA
Sulfate (SO_4)	14.5 mg/L	14.4 mg/L	250 mg/L(b)
pH (field)	6.9	NA	SNA
Solids, Dissolved @ 180°C	924 mg/L	932 mg/L	500 mg/L(b)
Specific Conductance @ 25°C (field)	1,800 µmhos/cm	NA	SNA
Total Alkalinity	560 mg/L	566 mg/L	SNA
Nitrate (as N)	0.40 mg/L	0.41 mg/L	10 mg/L(a)
Orthophosphate	<0.01 mg/L	<0.01 mg/L	SNA

NA Not analyzed a second time. Temperature, specific conductance, and pH were only measured once in the field.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 4-7

COMPARISON OF ASH EXTRACTS METALS ANALYSES WITH LEACHATE METALS ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZC

Parameter	Samples (in µg/L)							Standards/Criteria (in µg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate[c]	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Arsenic	ND	ND-45	ND-22	ND	ND-60	ND	ND	5,000	50	SNA
Barium	148-245	139-192	23-198	197-275	12-223	129-182	7.8-8.0	100,000	1,000	SNA
Cadmium	30-110	ND	897-1,200	646-1,020	758-1,380	ND-6.0	ND	1,000	10	SNA
Chromium	6.8-9.8	8.6-16	36-72	5.6-8.0	162-265	5.9-8.3	ND	5,000	50	SNA
Copper	33-146	12-46	929-2,300	50-291	41-1,200	8.5-36	ND	SNA	SNA	1,000
Iron	ND-33	ND-14	3,160-24,300	ND-113	14,400-46,300	ND-97	108-115	SNA	SNA	300
Lead	44-159	ND-53	5,180-10,400	337-2,960	8,090-11,700	ND-201	ND-34	5,000	50	SNA
Manganese	788-1,420	ND-20	2,600-8,540	1,900-5,170	2,750-7,370	ND-6.4	493-501	SNA	SNA	50
Mercury	ND	ND-0.32	ND-0.67	ND-0.49	0.32-0.44	ND-1.1	ND	200	2	SNA
Selenium	ND	ND	ND	ND	ND	ND	ND	1,000	10	SNA
Silver	ND	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Sodium	139,000-166,000	140,000-189,000	129,000-158,000	1,510,000-1,640,000	123,000-170,000	124,000-160,000	188,000-191,000	SNA	SNA	SNA
Zinc	4,370-127,000	37-270	57,000-80,100	24,300-47,400	51,900-94,400	30-132	9-13	SNA	SNA	5,000
Aluminum Oxide	70-106	50,400-203,000	20,000-34,500	ND-1,320	98,200-118,000	74,500-118,000	ND	SNA	SNA	
Calcium Oxide	621,000-759,000	141,000-193,000	1,300,000-1,600,000	1,110,000-1,330,000	1,500,000-1,820,000	142,000-199,000	64,600-65,800	SNA	SNA	SNA
Magnesium Oxide	23,200-34,700	42-318	47,800-63,000	39,400-375,000	59,700-83,600	49-430	22,600-23,000	SNA	SNA	SNA
Potassium Monoxide	108,000-142,000	116,000-159,000	110,000-127,000	83,200-134,000	91,200-1,110,000	104,000-136,000	79,700-81,200	SNA	SNA	SNA
Silicon Dioxide	20,000-34,500	503-1,560	20,900-79,000	22,400-51,700	7,170-48,700	518-1,410	4,570-4,840	SNA	SNA	SNA

ND Not Detected
SNA Standard Not Available

(a) Primary Drinking Water Standards
(b) Secondary Drinking Water Standards
(c) Results for aluminum, calcium, magnesium, potassium, and silicon are for metals and not oxides.

TABLE 4-8

COMPARISON OF ASH EXTRACTS CONVENTIONAL ANALYSES WITH LEACHATE CONVENTIONAL ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZC

Parameter	Samples (in mg/L)							Standards/Criteria (in mg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[(a)] MCLs	Safe Drinking Water Act[(b)] SMCLs
Ammonia-Distilled (as N)	0.12-0.19	0.16-0.24	0.19-0.30	0.15-0.19	0.18-0.32	2.8-3.02	68.2-77.4	SNA	SNA	SNA
Total Organic Carbon	NA	4.51-7.35	NA	NA	NA	2.58-5.54	47.2-49.3	SNA	SNA	SNA
Chloride	173-195	181-230	183-226	189-255	196-281	NA	NA	SNA	SNA	250
Sulfate	587-777	187-448	727-1,650	585-984	536-1,140	NA	14.4-14.5	SNA	SNA	250
Solids, Dissolved @ 180°C	NA	1,050-1,320	NA	NA	NA	NA	924-932	SNA	SNA	500
Total Alkalinity	NA	228-696	NA	NA	NA	NA	560-566	SNA	SNA	SNA
Nitrate (as N)	0.07-1.59	0.06-0.94	0.31-0.71	0.25-1.33	0.08-15.3	NA	0.40-0.41	SNA	10	SNA
Orthophosphate	ND-0.02	ND-0.01	ND-0.22	ND-0.01	0.79-2.04	ND-0.01	ND	SNA	SNA	SNA
Extract's Initial pH	5.74-5.93	10.52-10.70	10.63-10.84	4.86-5.01	3.28-3.64	10.20-10.41	NA	SNA	SNA	SNA
Extract's Final pH	6.68-6.99	10.28-10.60	4.97-5.02	5.99-7.00	4.63-4.79	10.25-10.63	NA	SNA	SNA	SNA

NA Not analyzed due to differences in scope of work.
ND Not Detected.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

5

5.0 FACILITY ZD FINDINGS

5.1 FACILITY ZD DESCRIPTION

Facility ZD consists of two mass-burn, water-wall boilers. Refuse is charged into the boiler by overhead cranes, moves inside the boilers on grates, and is discharged into an ash quench tank located below the boilers. Fly ash in the exhaust gas is collected and mixed with the bottom ash for disposal. The steam generated by the facility is used to generate electricity, which is sold to a local utility. The following details outline operational information for this facility.

Refuse Feed Rate:	750 tons/day/boiler.
Operating Temperature:	2,400-2,600° F.
Residence Time:	Approximately 45 minutes in boiler where the grates can be slowed to allow wet loads more time to dry out; approximately 10 minutes from ash quench to ash pile.
Backup Fuel:	None.
Air Feed Information:	Primary air comes from the charging floor and tipping floor. Secondary air comes from outside the building. Neither is preheated.
Refuse Feed Method:	Refuse is dumped on the tipping floor. The tipping floor is covered, but is not totally enclosed. Old and new waste is mixed with an overhead crane. Mixing of the waste did not appear to be done frequently. The overhead crane loads the waste into the feed hopper on the boilers.
Trash Accepted:	Residential (90%) and commercial/light industrial (10%) waste generated in surrounding communities. No sewage sludge, pathological, hazardous, biological, dental, or liquid wastes are accepted.
Source of Ash Quench Water:	Ash quench water consists of blowdowns from cooling tower and boiler and cooling water. City water is used as makeup water.

Ash-Handling Equipment

The bottom ash is discharged into one of two quench tanks, which are equipped with drag flight conveyors. The ash settles to the bottom of the quench tank and is moved along by the drag flights, then travels up an incline, and is discharged into a trommel with 3-inch openings. The material that is larger than 3 inches in size travels through the trommel and is deposited in a truck. This material is then sent to an onsite magnetic separator, where the ferrous metal is removed. Any remaining material is added to the waste in the receiving trench and is sent back through the incinerator. The material that is smaller than 3 inches in size drops through the trommel onto a vibrating conveyor. A rotating magnet is used to remove the ferrous material. All other material is deposited in a truck for disposal in the ash fill.

The fly ash is removed from the exhaust gas by electrostatic precipitators (ESPs) and is mixed with the bottom ash in the quench tanks. The drag flights are shut down when trucks are being switched.

The ash samples at Facility ZD were collected from the vibrating conveyor just after the electromagnet removed the ferrous material and just before the ash was deposited in the truck used to transport it to the ash disposal facility. This MWC facility had two ash conveyors that it could use to move the ash from the ash quench tanks to the ash trucks. All of the samples were collected from just one ash conveyor.

5.2 CHEMICAL CHARACTERIZATION OF ASH

Table 5-1 presents the results of the semivolatile analysis of the ash samples from Facility ZD. The data in this table indicate that some phthalates were detected in sample ZD-AH-003, the only sample from this facility analyzed for the Appendix IX semivolatiles. These compounds appear to be the result of laboratory contamination. The data also indicate that low levels of phenanthrene (310 ppb) and fluoranthene (170 ppb) were detected in sample ZD-AH-003. Phenanthrene and fluoranthene are polynuclear aromatic hydrocarbons (PAHs) and are common products of the combustion of organic material.

Table 5-2 presents the results of the polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD/PCDF) analyses of sample ZD-AH-003. Toxicity equivalency values were calculated using EPA's methodology (EPA, March 1987) and are presented in this table. The data in this table indicate that the PCDDs/PCDFs levels found in the ash are below the Centers for Disease Control (CDC) recommended upper level of 2,3,7,8-TCDD toxicity equivalency of 1 part per billion in residential soil (Kimbrough, 1984).

The results of the metals analyses for the ash from this facility are presented in Table 5-3. The data in this table indicate that, except for chromium, copper, lead, and zinc, the results were fairly constant during the week of sampling.

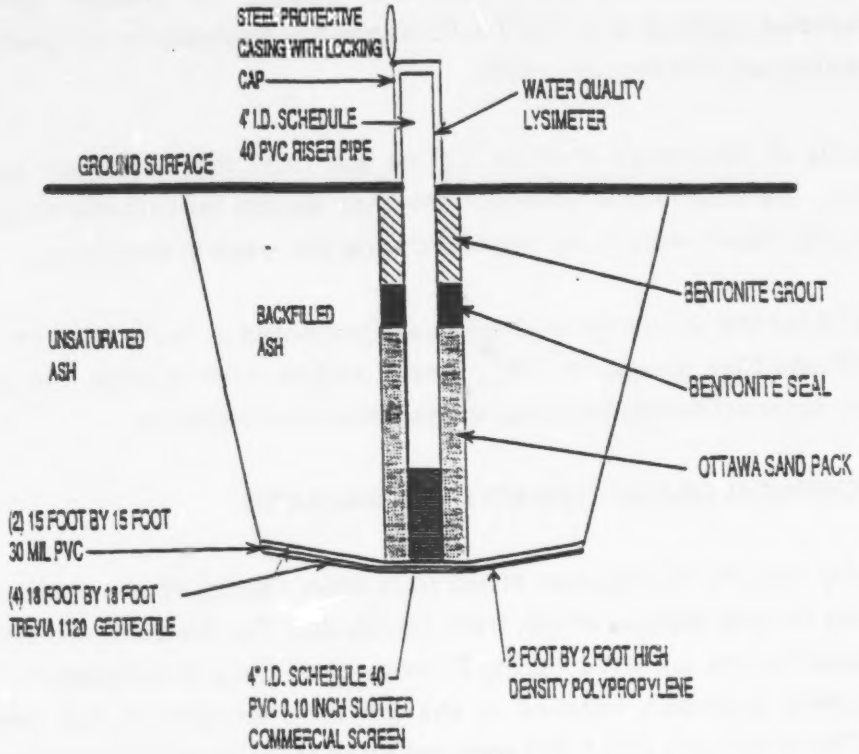
The results for the conventional analyses are presented in Table 5-4. The data in this table indicate that, except for TOC, nitrate, sulfate, and chloride, the results were also fairly constant during the week the samples were collected.

5.3 CHEMICAL CHARACTERIZATION OF LEACHATES

The facility used for the disposal of ash from MWC Facility ZD is unlined and is used exclusively for the disposal of ash from Facility ZD. The leachate samples from the ash disposal facility for MWC Facility ZD were grab samples collected from shallow water quality lysimeters installed in the ash fill after the ash had been placed. Samples ZD-LE-001 and ZD-LE-003 were collected from the same lysimeter in an area of more recently disposed ash. Sample ZD-LE-002 was collected from a lysimeter in an area of older ash. Figure 5-1 gives a general description of the lysimeter's construction.

No Appendix IX semivolatile compounds or PCDDs/PCDFs were detected in the leachate samples from the ash disposal facility for MWC Facility ZD.

The results for the metals analysis of the leachate samples are shown in Table 5-5. The data in this table indicate that the results for all three samples are generally consistent. However, the results for ZD-LE-002, which was collected in an area of older ash, are generally lower than the results for the other two samples.


STEEL PROTECTIVE CASING WITH LOCKING CAP
4" I.D. SCHEDULE 40 PVC RISER PIPE
WATER QUALITY LYSIMETER
GROUND SURFACE
BENTONITE GROUT
BACKFILLED ASH
UNSATURATED ASH
BENTONITE SEAL
OTTAWA SAND PACK
(2) 15 FOOT BY 15 FOOT 30 MIL PVC
(4) 18 FOOT BY 18 FOOT TREVIA 1120 GEOTEXTILE
4" I.D. SCHEDULE 40 PVC 0.10 INCH SLOTTED COMMERCIAL SCREEN
2 FOOT BY 2 FOOT HIGH DENSITY POLYPROPYLENE

NOTE: ILLUSTRATION NOT TO SCALE

WATER QUALITY LYSIMETER ID	TOTAL DEPTH BELOW GRADE (Feet)	THICKNESS BENTONITE CEMENT GROUT (Feet)	THICKNESS BENTONITE SEAL (Feet)	THICKNESS OF OTTAWA SAND (Feet)
B-3A	9.5	2.25	2.25	5.0
C-1AA	10.5	4.0	2.25	4.25
C-4A	10.0	3.5	2.0	4.5
E-1A	10.25	3.75	2.0	4.5

FIGURE 5-1

WATER QUALITY LYSIMETER INSTALLATION DETAIL

The data in Table 5-5 also indicate that none of the metals exceeded the EP Toxicity Maximum Allowable Limits. Although the leachates are not required to meet Drinking Water Standards, a comparison of the leachate results with the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988) was made. This comparison indicates that the results for all but iron and manganese met these standards.

Table 5-6 presents the results of the conventional analyses of the leachate samples. TDS values ranged from 8,030 mg/L to 13,000 mg/L.

5.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS

No PCDDs/PCDFs were detected in the composite sample from the deionized water extracts of the ash from MWC Facility ZD.

Table 5-7 presents the results of the Appendix IX semivolatile analysis of the composite sample from the deionized water extract of the ash from MWC Facility ZD. Benzoic acid (26 ppb) was the only Appendix IX semivolatile compound found in this composite sample. This table also indicates that no Appendix IX semivolatile compounds were detected in the leachate samples from the ash fill serving this facility.

Table 5-8 presents the range of results of the metals analyses of the ash extracts from MWC Facility ZD and the range of results of the leachate samples from the ash fill serving this facility. For comparison, this table also lists the EP Toxicity Maximum Allowable Limits, and the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988).

The results presented in Table 5-8 indicate that the extracts from the EP Toxicity, the TCLP 1, and the TCLP 2 extraction techniques generally contain higher concentrations of metals than the extracts produced by the other extraction techniques. For this facility, the extracts from the EP toxicity, the TCLP 1, and the TCLP 2 extraction techniques exceeded the EP Toxicity Maximum Allowable Limits established in Section 261.24 of 40 CFR 261 for cadmium and lead.

Although the ash extracts would not be required to meet Drinking Water Standards, a comparison of the ash extract results with the Drinking Water Standards was made. This comparison indicates that the majority of the metals results met these standards.

Table 5-9 presents the range of results of the conventional analyses of the ash extracts from MWC Facility ZD and the leachate samples from the ash fill serving this facility. For comparison, this table also lists the Primary Drinking Water Standards for nitrate, as well as the Secondary Drinking Water Standards for chloride, sulfate, and Total Dissolved Solids (TDS).

TABLE 5-1

ASH SEMIVOLATILE RESULTS - SAMPLE ZD-AH-003
FACILITY ZD

Parameter	Ash Sample Result (µg/kg)
Bis(2-ethylhexyl)phthalate	390JB
Di-n-butyl phthalate	270JB$_1$
Fluoranthene	170J
Phenanthrene	310J

J	Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limit.
B	Laboratory identified compound as not being detected substantially above the level reported in laboratory blanks. Laboratory may be the source of the compound.
B$_1$	Compound was identified during data validation as not being detected substantially above the level reported in the laboratory blanks. Laboratory may be the source of the contamination.

TABLE 5-2

ASH DIOXIN RESULTS - SAMPLE ZD-AH-003
FACILITY ZD

PCDD/PCDF Homolog	Ash Sample Result pg/g (ppt)	Toxicity Equivalency Factor(1)	Toxicity Equivalent (ppt)
2,3,7,8-TCDD	35	1.0	35
Other TCDD	541	0.01	5.41
1,2,3,7,8-PeCDD	ND	0.5	0
Other PeCDD	1,910	0.005	9.55
1,2,3,4,7,8-H_XCDD	86	0.04	3.44
1,2,3,6,7,8-H_XCDD	148	0.04	5.92
1,2,3,7,8,9-H_XCDD	194	0.04	7.76
Other H_XCDD	853	0.0004	0.34
1,2,3,4,6,7,8-H_PCDD	1,555	0.001	1.56
Other H_PCDD	1,384	0.00001	0.0138
OCDD	4,519	0	0
2,3,7,8-TCDF	626	0.1	62.6
Other TCDF	2,633	0.001	2.63
1,2,3,7,8-PeCDF	151	0.1	15.1
2,3,4,7,8-PeCDF	171	0.1	17.1
Other PeCDF	1,736	0.001	1.74
1,2,3,4,7,8-H_XCDF	654	0.01	6.54
1,2,3,6,7,8-H_XCDF	660	0.01	6.60
1,2,3,7,8,9-H_XCDF	479	0.01	4.79
2,3,4,6,7,8-H_XCDF	124	0.01	1.24
Other H_XCDF	1,686	0.0001	0.169
1,2,3,4,6,7,8-H_PCDF	1,842	0.001	1.84
1,2,3,4,7,8,9-H_PCDF	119	0.001	0.119
Other H_PCDF	384	0.00001	0.00384
OCDF	893	0	0
Total Toxicity Equivalent			189 ppt

ND - Not detected below 221 pg/g.

(1)Toxicity Equivalency Factors are EPA's current recommended factors (EPA, March 1987).

TABLE 5-3

ASH METALS ANALYSES
FACILITY ZD

Parameter	Samples				
	ZD-AH-001	ZD-AH-002	ZD-AH-003	ZE-AH-004	ZD-AH-005
METALS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Arsenic	30	54	43	44	36
Barium	411	440	545	434	432
Cadmium	51	66	69	42	39
Chromium	87	199	70	54	52
Copper	1,050	960	1,490	959	1,800
Iron	34,600	37,100	27,400	31,100	22,900
Lead	4,090	5,040	2,980	2,860	22,400
Manganese	574	609	618	965	636
Mercury	0.91	1.5	2.1	0.55	0.97
Selenium	2.9	ND	3.1	3.9	3.2
Silver	7.5	9.4	11	6.3	7.6
Sodium	6,050	6,480	6,500	6,100	5,890
Zinc	5,660	6,560	8,000	4,930	4,260
METAL OXIDES	(%)	(%)	(%)	(%)	(%)
Aluminum Oxide	12	12	13	9.9	11
Calcium Oxide	11	11	10	12	11
Magnesium Oxide	2.0	1.9	2.2	2.2	1.8
Potassium Monoxide	1.4	1.1	0.79	1.1	0.98
Silicon Dioxide	35	37	35	32	36

ND Not detected.

TABLE 5-4

ASH CONVENTIONAL ANALYSES
FACILITY ZD

Parameter	Units	Samples				
		ZD-AH-001	ZD-AH-002	ZD-AH-003	ZD-AH-004	ZD-AH-005
pH	S.U.	10.69	10.60	10.51	10.36	10.46
Moisture Content*	%	0.4	1.6	1.2	1.2	0.9
TOC	mg/kg	25,800	30,000	52,100	11,400	53,200
Total Soluble Solids	mg/kg	6,850	13,200	6,440	8,740	7,150
Ammonia	mg/kg	1.00	1.04	1.02	0.90	1.08
Nitrate	mg/kg	1.59	1.14	0.44	0.96	0.72
Orthophosphate	mg/kg	ND	0.05	0.05	0.05	0.05
Total Alkalinity	mg/kg	852	558	786	852	922
Chloride	mg/kg	1,270	2,190	766	854	869
Sulfate	mg/kg	2,220	5,580	1,680	2,360	1,800

ND Not detected.
* Determined after samples were prepared.

TABLE 5-5

LEACHATE METALS ANALYSES
FACILITY ZD

Parameter	Samples (µg/L)			Standards/Criteria (µg/L)		
	ZD-LE-001	ZD-LE-002	ZD-LE-003	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Aluminum	ND	ND	ND	SNA	SNA	SNA
Arsenic	ND	ND	ND	5,000	50	SNA
Barium	40	18	38	100,000	1,000	SNA
Cadmium	ND	ND	ND	1,000	10	SNA
Calcium	477,000	386,000	470,000	SNA	SNA	SNA
Chromium	ND	ND	ND	5,000	50	SNA
Copper	12	4.6	7.3	SNA	SNA	1,000
Iron	187	523	211	SNA	SNA	300
Lead	ND	ND	ND	5,000	50	SNA
Magnesium	345,000	367,000	340,000	SNA	SNA	SNA
Manganese	795	718	857	SNA	SNA	50
Mercury	ND	ND	ND	200	0.2	SNA
Potassium	636,000	229,000	632,000	SNA	SNA	SNA
Selenium	ND	ND	ND	1,000	10	SNA
Silicon	15,300	8,760	14,900	SNA	SNA	SNA
Silver	ND	ND	ND	5,000	50	SNA
Sodium	2,480,000	1,340,000	2,580,000	SNA	SNA	SNA
Zinc	8.7	ND	5.2	SNA	NA	5,000

ND Not detected.
SNA Standard Not Available.

(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 5-6

LEACHATE CONVENTIONAL ANALYSES
FACILITY ZD

Parameter	Samples			Standards/Criteria
	ZD-LE-001	ZD-LE-002	ZD-LE-003	Primary and Secondary Drinking Water Quality Standards
Ammonia-Distilled (as N)	4.38 mg/L	28.4 mg/L	NA(2)	SNA
Organic Carbon	28.8 mg/L	30.7 mg/L	NA(2)	SNA
Temperature (field)	30°C	19°C	30°C	SNA
Sulfate (SO_4)	4,920 mg/L	4,140 mg/L	5,080 mg/L	250 mg/L(b)
pH (field)	NA(1)	NA(1)	NA(1)	SNA
Solids, Dissolved @ 180°C	12,700 mg/L	8,030 mg/L	13,000 mg/L	500 mg/L(b)
Specific Conductance @ 25°C (field)	> 10,000 μmhos/cm	9,400 μmhos/cm	> 10,000 μmhos/cm	SNA
Total Alkalinity	709 mg/L	744 mg/L	711 mg/L	SNA
Nitrate (as N)	0.04 mg/L	<0.01 mg/L	<0.01 mg/L	10 mg/L(a)
Orthophosphate	0.24 mg/L	0.17 mg/L	0.22 mg/L	SNA

* pH meter was not working properly.
(1) Not analyzed due to pH meter not working properly.
(2) Not analyzed since this sample was a duplicate of ZD-LE-001 and only selected parameters were analyzed for.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 5-7

COMPARISON OF ASH EXTRACT SEMIVOLATILE RESULTS TO LEACHATE SEMIVOLATILE RESULTS FACILITY ZD

Parameter	Samples (µg/L)	
	Deionized Water Extract	Leachate
Benzoic Acid	26 JT	ND

ND Not Detected.

J Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limits.

T The mass spectrum does not meet EPA CLP criteria for confirmation, but compound presence is strongly suspected.

TABLE 5-8

COMPARISON OF ASH EXTRACTS METALS ANALYSES WITH LEACHATE METALS ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZD

Parameter	Samples (in µg/L)							Standards/Criteria (in µg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate[c]	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Arsenic	ND	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Barium	227-502	201-285	162-290	245-418	110-586	166-262	18-40	100,000	1,000	SNA
Cadmium	167-354	ND	195-1,100	426-1,150	601-1,560	ND	ND	1,000	10	SNA
Chromium	ND	ND	ND-49	ND-8.0	145-799	ND	ND	5,000	50	SNA
Copper	42-246	34-80	24-1,550	8.5-858	125-1,400	32-82	4.6-12	SNA	SNA	1,000
Iron	ND-45	ND	1,200-27,100	ND-7,220	32,800-103,000	ND	187-523	SNA	SNA	300
Lead	127-504	ND	3,490-19,700	4,050-10,500	22,700-26,400	ND-43	ND	5,000	50	SNA
Manganese	931-1,420	ND	1,320-4,900	1,940-3,110	3,350-5,750	ND	718-857	SNA	SNA	50
Mercury	ND-0.77	ND-0.90	ND-0.29	ND-0.53	ND	0.27-0.53	ND	200	2	SNA
Selenium	ND	ND	ND	ND	ND	ND	ND	1,000	10	SNA
Silver	ND	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Sodium	24,800-49,800	24,100-42,600	33,600-52,500	1,380,000-1,430,000	38,700-68,300	24,200-42,100	1,340,000-2,580,000	SNA	SNA	SNA
Zinc	15,200-30,600	5.4-24	30,300-95,600	43,400-79,500	61,000-164,000	12-35	ND-8.7	SNA	SNA	5,000
Aluminum Oxide	ND-204	71,000-97,900	4,870-18,200	344-6,090	88,600-130,000	72,300-84,200	ND	SNA	SNA	SNA
Calcium Oxide	398,000-759,000	199,000-255,000	592,000-1,250,000	666,000-970,000	949,000-1,670,000	194,000-246,000	386,000-477,000	SNA	SNA	SNA
Magnesium Oxide	35,000-59,300	71-156	42,600-86,500	56,300-73,000	94,100-121,000	52-319	340,000-367,000	SNA	SNA	SNA
Potassium Monoxide	12,300-33,400	13,100-30,400	17,000-38,600	14,600-32,000	15,100-40,900	14,500-31,200	229,000-636,000	SNA	SNA	SNA
Silicon Dioxide	24,000-29,700	402-642	27,400-49,100	25,600-33,400	118,000-143,000	703-989	8,760-15,300	SNA	SNA	SNA

ND	Not Detected
SNA	Standard Not Available

(a) Primary Drinking Water Standards

(b) Secondary Drinking Water Standards

(c) Results for aluminum, calcium, magnesium, potassium, and silicon are for metals and not oxides

TABLE 5-9

COMPARISON OF ASH EXTRACTS CONVENTIONAL ANALYSES WITH LEACHATE CONVENTIONAL ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZD

Parameter	Samples (in mg/L)							Standards/Criteria (in mg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[(a)] MCLs	Safe Drinking Water Act[(b)] SMCLs
Ammonia-Distilled (as N)	0.07-0.09	0.08-0.17	0.12-0.20	0.12-0.14	0.16-0.20	3.56-4.1	4.38-28.4	SNA	SNA	SNA
Total Organic Carbon	NA	9.19-18.9	NA	NA	NA	9.94-19.7	28.8-30.7	SNA	SNA	SNA
Chloride	39.7-77.2	34.2-70.2	43.5-82.2	83.9-109	56.4-141	NA	NA	SNA	SNA	250
Sulfate	336-572	247-371	197-629	360-703	438-872	NA	4,140-5,080	SNA	SNA	250
Solids, Dissolved @ 180°C	NA	598-842	NA	NA	NA	NA	8,030-13,000	SNA	SNA	500
Total Alkalinity	NA	201-288	NA	NA	NA	NA	709-744	SNA	SNA	SNA
Nitrate (as N)	0.20-0.26	0.03-0.18	0.03-0.16	0.03-0.07	0.01-0.12	NA	ND-0.04	SNA	10	SNA
Orthophosphate	ND-0.06	ND	ND-0.06	0.01-0.04	0.48-1.66	ND-0.01	0.17-0.24	SNA	SNA	SNA
Extract's Initial pH	4.58-4.96	9.97-10.10	8.82-10.20	4.85-4.95	3.16-3.55	9.19-9.72	NA	SNA	SNA	SNA
Extract's Final pH	6.42-6.71	10.18-10.44	4.96-5.18	5.69-6.34	4.10-4.41	9.88-10.31	NA	SNA	SNA	SNA

NA Not analyzed due to differences in scope of work.
ND Not Detected
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

6

6.0 FACILITY ZE FINDINGS

6.1 FACILITY ZE DESCRIPTION

Facility ZE consists of two mass-burn, water-wall boilers. Refuse is charged into the boilers by overhead cranes, moves inside the boilers on grates, and is discharged into ash quench reactors on the bottom of the boilers. Dry lime is added to the flue gas where it is mixed with the fly ash. This mixture is then collected in electrostatic precipitators and mixed in with the bottom ash for disposal. The steam generated at the facility is used to generate electricity, which is sold to a local utility. The following details outline the operational information for this facility.

Startup Date:	September 1987.
Refuse Feed Rate:	750 tons/day/boiler.
Operating Temperature:	1,800° F.
Residence Time:	Approximately 1 hour in the boiler, where the grates can be slowed to allow wet loads more time to dry out.
Backup Fuel:	Natural gas--is used during start ups and shut downs and if the boiler drops below 1,800° F.
Air Feed Information:	Both primary and secondary air comes from the tipping floor. Air is not normally preheated, but the facility has the capability to preheat air.
Refuse Feed Method:	Refuse is dumped onto the tipping floor, where new refuse is mixed with the old refuse with an overhead crane. Two cranes work during the hours in which trucks are unloading. The pit at ZE is the largest pit of any of the facilities studied; thus it is easier for the crane operator(s) to keep areas open for trucks to discharge. The overhead cranes load the refuse into the feed hoppers on the boilers.
Trash Accepted:	Any residential (65% of total) and commercial/light industrial (35% of total) waste generated in surrounding communities. Table 6-1 lists the material accepted at this facility.

Source of Ash Quench Water:	Ash quench water consists of any water used in the process (spray drier) and water used in other parts of the plant.
Electricity Generated:	45 Megawatts/hour.
Electricity Used by Facility:	7 Megawatts/hour.

Ash-Handling Equipment

The bottom ash is discharged from the ash quench reactors onto a vibrating conveyor. This conveyor dumps the ash onto an inclined conveyor. The inclined conveyor discharges onto a grizzly, where large items (material greater than 10 inches) are separated out. The smaller material (material less than 10 inches) passes through the grizzly and is discharged into ash bins for transportation to the ash disposal facility.

Fly ash from the generator and the economizer areas is discharged into the ash quench reactors, where it is mixed with the bottom ash. Fly ash from the spray drier (where a lime slurry is injected into the flue gas) and the electrostatic precipitators is transported to a drum, where water is added to the fly ash/lime mixture. This mixture is then discharged onto the inclined conveyor and mixed with the bottom ash.

The ash samples at Facility ZE were collected from the end of the inclined belt just before the ash passed through the grizzly into the ash bins.

6.2 CHEMICAL CHARACTERIZATION OF ASH

No Appendix IX semivolatiles were detected in sample ZE-AH-003, the only sample from this facility analyzed for the Appendix IX semivolatiles. This sample did contain 98 ng/g (ppb) of dichlorobiphenyl (PCB). This was the only PCB cogener detected in this sample.

Table 6-2 presents the results of the polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD/PCDF) analyses of sample ZE-AH-003. Toxicity equivalency values were calculated using EPA's methodology (EPA, March 1987) and are presented in this table. The data in this table indicate that the PCDDs/PCDFs levels found in the ash are substantially below the Centers for Disease Control (CDC) recommended upper level of 2,3,7,8-TCDD toxicity equivalency of 1 part per billion in residential soil (Kimbrough, 1984).

The results of the metals analyses for the ash from this facility are presented in Table 6-3. The data in this table indicate that, except for chromium, mercury, and zinc, the results were fairly constant during the week of sampling.

The results for the conventional analyses are presented in Table 6-4. The data in this table indicate that, except for TOC, total soluble solids, ammonia, and total alkalinity, the results were also fairly constant during the week.

6.3 CHEMICAL CHARACTERIZATION OF LEACHATES

The facility used for the disposal of ash from MWC Facility ZE is lined and is used exclusively for the disposal of ash from Facility ZE. The leachate samples from the ash disposal facility for MWC Facility ZE were grab samples collected from the same leachate collection sump.

The results for the semivolatile analysis of these samples are presented in Table 6-5. As shown in this table only benzoic acid was detected in both samples; 73 ppb in one sample and 52 ppb in the second.

No PCDDs/PCDFs or PCBs were detected in the leachate samples from this ash fill.

The results for the metals analysis of the leachate samples are shown in Table 6-6. The data in this table indicate that none of the compounds exceeded their EP Toxicity Maximum Allowable Limit. Although the leachates are not required to meet Drinking Water Standards, a comparison of the leachate results with the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988) was made. This comparison indicates that the results of all but barium, iron and manganese met these standards in the leachates.

Table 6-7 presents the results of the conventional analyses of the leachate samples. TDS values ranged from 25,900 mg/L to 26,300 mg/L, and the pH of the leachate was 5.2.

6.4 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS

No PCDDs/PCDFs or PCBs were detected in the composite sample from the deionized water extracts of the ash from MWC Facility ZE.

Table 6-8 presents the results of the Appendix IX semivolatile analysis of the composite sample from the deionized water extracts of the ash from MWC Facility ZE. Benzoic acid (66 ppb) was the only Appendix IX semivolatile compound detected in this composite sample. This table also indicates that benzoic acid (52 and 73 ppb) was the only Appendix IX semivolatile compound found in the leachate samples from the ash fill serving this facility.

Table 6-9 presents the range of results of the metals analyses of the ash extracts from MWC Facility ZE and the range of results for the leachate samples from the ash fill serving this facility. For comparison, this table also lists the EP Toxicity Maximum Allowable Limits, and the Primary and Secondary Drinking Water Standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988).

The results presented in Table 6-9 indicate that the extracts from the EP Toxicity and the TCLP 2 extraction techniques generally contain higher concentrations of metals than the extracts produced by the other extraction techniques.

For this facility, the extracts from the EP Toxicity and the TCLP 2 extraction techniques exceeded the EP Toxicity Maximum Allowable Limits established in Section 261.24 of 40 CFR 261 for lead.

Although the ash extracts would not be required to meet Drinking Water Standards, a comparison of the ash extract results with the Drinking Water Standards was made. This comparison indicates that the majority of the metals results met these standards.

Table 6-10 presents the range of results of the conventional analyses of the ash extracts from MWC Facility ZE and the leachate samples from the ash fill serving this facility. For comparison, this table also lists the Primary Drinking Water Standards for nitrate, as well as the Secondary Drinking Water Standards for chloride, sulfate, and Total Dissolved Solids (TDS).

TABLE 6-1

ACCEPTABLE WASTE
FACILITY ZE

Acceptable waste means household garbage, trash, rubbish and refuse.

Acceptable waste excludes: pathological and biological waste; oil sludge; large concentrations of plastics; cesspool or other human waste; human and animal remains; large automobile and vehicular parts; tires; trailers; agricultural equipment; marine vessels or similar items; farm and other large machinery; wire and cable; tree logs and wood greater than six (6) feet in length and six (6) inches in diameter; tree stumps greater than twelve (12) inches in diameter; liquid wastes; non-burnable construction material and/or demolition debris; wallboard; asbestos and asbestos products; explosives (including ammunition and firearms); chemicals (including any empty containers thereof); radioactive materials and hazardous refuse of any kind (including any empty containers thereof) such as cleaning fluids; flammables; petroleum products (including drained oil); cutting oils; paints; acids; caustics; pesticides; insecticides; poisons, drugs; or any other materials that would be likely to cause the Facility to violate an air or water quality effluent standard or to pose a threat to health or safety or which may cause damage to or adversely affect the operation of the Facility.

TABLE 6-2

ASH DIOXIN RESULTS - SAMPLE ZE-AH-003
FACILITY ZE

PCDD/PCDF Homolog	Ash Sample Result pg/g (ppt)	Toxicity Equivalency Factor(1)	Toxicity Equivalent (ppt)
2,3,7,8-TCDD	10	1.0	10
Other TCDD	120	0.01	1.2
1,2,3,7,8-PeCDD	35	0.5	17.5
Other PeCDD	248	0.005	1.24
1,2,3,4,7,8-H_XCDD	11	0.04	0.44
1,2,3,6,7,8-H_XCDD	11	0.04	0.44
1,2,3,7,8,9-H_XCDD	22	0.04	0.88
Other H_XCDD	104	0.0004	0.042
1,2,3,4,6,7,8-H_PCDD	122	0.001	0.122
Other H_PCDD	0	0.00001	0
OCDD	294	0	0
2,3,7,8-TCDF	176	0.1	17.6
Other TCDF	1,136	0.001	1.14
1,2,3,7,8-PeCDF	52	0.1	5.2
2,3,4,7,8-PeCDF	43	0.1	4.3
Other PeCDF	448	0.001	0.448
1,2,3,4,7,8-H_XCDF	95	0.01	0.95
1,2,3,6,7,8-H_XCDF	134	0.01	1.34
1,2,3,7,8,9-H_XCDF	45	0.01	0.45
2,3,4,6,7,8-H_XCDF	20	0.01	0.20
Other H_XCDF	280	0.0001	0.028
1,2,3,4,6,7,8-H_PCDF	155	0.001	0.155
1,2,3,4,7,8,9-H_PCDF	16	0.001	0.016
Other H_PCDF	44	0.00001	0.00044
OCDF	59	0	0
Total Toxicity Equivalent			63.7 ppt

(1) Toxicity equivalency factors are EPA's current recommended factors, (EPA, March 1987).

TABLE 6-3

ASH METALS ANALYSES
FACILITY ZE

Parameter	Samples				
	ZE-AH-001	ZE-AH-002	ZE-AH-003	ZE-AH-004	ZE-AH-005
METALS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Arsenic	16	17	19	15	20
Barium	407	491	505	391	792
Cadmium	34	35	38	37	18
Chromium	665	71	87	67	70
Copper	990	1,300	1,820	1,500	930
Iron	34,600	43,000	45,100	40,200	33,900
Lead	1,550	1,380	1,170	1,170	1,600
Manganese	593	640	531	598	581
Mercury	7.6	4.7	13	4.8	3.2
Selenium	ND	ND	ND	4.7	ND
Silver	4.4	5.6	5.4	13	11
Sodium	6,750	6,410	7,500	5,880	7,700
Zinc	8,280	3,530	3,600	3,400	2,120
METAL OXIDES	(%)	(%)	(%)	(%)	(%)
Aluminum Oxide	11	9.7	10	10	10
Calcium Oxide	15	14	13	14	13
Magnesium Oxide	2.0	1.6	1.9	1.8	1.6
Potassium Monoxide	1.2	1.2	1.4	0.95	1.0
Silicon Dioxide	31	31	35	30	32

ND Not Detected.

TABLE 6-4

ASH CONVENTIONAL ANALYSES
FACILITY ZE

Parameter	Units	Samples				
		ZE-AH-001	ZE-AH-002	ZE-AH-003	ZE-AH-004	ZE-AH-005
pH	S.U.	11.61	11.69	11.71	11.40	11.82
Moisture Content*	%	2.5	1.9	1.4	1.3	0.6
TOC	mg/kg	34,000	8,920	4,060	7,290	43,300
Total Soluble Solids	mg/kg	22,900	25,900	35,500	26,100	11,200
Ammonia	mg/kg	5.05	3.64	8.69	7.32	2.77
Nitrate	mg/kg	2.90	3.19	4.51	4.10	4.23
Orthophosphate	mg/kg	ND	ND	ND	ND	ND
Total Alkalinity	mg/kg	3,490	4,710	2,990	7,310	7,590
Chloride	mg/kg	9,220	10,900	14,100	10,400	7,550
Sulfate	mg/kg	2,190	1,500	2,790	2,530	2,270

ND Not detected.
* Determined after samples were prepared.

TABLE 6-5

LEACHATE SEMIVOLATILE ANALYSES
FACILITY ZE

Parameter	Samples (µg/L)	
	ZE-LE-001	ZE-LE-002
Benzoic acid	73	52

TABLE 6-6

LEACHATE METALS ANALYSES
FACILITY ZE

Parameter	Samples (µg/L)		Standards/Criteria (µg/L)		
	ZE-LE-001	ZE-LE-002	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Aluminum	ND	ND	SNA	SNA	SNA
Arsenic	ND	ND	5,000	50	SNA
Barium	3,080	2,970	100,000	1,000	SNA
Cadmium	ND	ND	1,000	10	SNA
Calcium	5,670,000	5,570,000	SNA	SNA	SNA
Chromium	ND	ND	5,000	50	SNA
Copper	ND	ND	SNA	SNA	1,000
Iron	10,500	7,480	SNA	SNA	300
Lead	ND	ND	5,000	50	SNA
Magnesium	14,800	15,000	SNA	SNA	SNA
Manganese	17,100	18,500	SNA	SNA	50
Mercury	ND	ND	200	2.0	SNA
Potassium	1,430,000	1,450,000	SNA	SNA	SNA
Selenium	ND	ND	1,000	10	SNA
Silicon	498	470	SNA	SNA	SNA
Silver	ND	ND	5,000	50	SNA
Sodium	2,430,000	2,470,000	SNA	SNA	SNA
Zinc	27	70	SNA	SNA	5,000

ND Not detected.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 6-7

LEACHATE CONVENTIONAL ANALYSES
FACILITY ZE

Parameter	Samples		Standards/Criteria
	ZE-LE-001	ZE-LE-002	Primary and Secondary Drinking Water Quality Standards
Ammonia-Distilled (as N)	9.78 mg/L	11.4 mg/L	SNA
Organic Carbon	28.9 mg/L	25.5 mg/L	SNA
Temperature (field)	23°C	NA	SNA
Sulfate (SO_4)	312 mg/L	309 mg/L	250 mg/L(b)
pH (field)	5.2	NA	SNA
Solids, Dissolved @ 180°C	26,300 mg/L	25,900 mg/L	500 mg/L(b)
Specific Conductance @ 25°C (field)	>10,000 µmhos/cm	NA	SNA
Total Alkalinity	95.2 mg/L	117 mg/L	SNA
Nitrate (as N)	0.01 mg/L	0.01 mg/L	10 mg/L(a)
Orthophosphate	<0.01 mg/L	<0.01 mg/L	SNA

NA Not analyzed a second time. Temperature, specific conductance and pH were only measured once in the field.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 6-8

COMPARISON OF ASH EXTRACT SEMIVOLATILE RESULTS TO LEACHATE SEMIVOLATILE RESULTS RANGES OF CONCENTRATIONS FACILITY ZE

Parameter	Samples (µg/L)	
	Deionized Water Extract	Leachates
Benzoic Acid	66T	52-73

T The mass spectrum does not meet EPA CLP criteria for confirmation, but compound presence is strongly suspected.

TABLE 6-9

COMPARISON OF ASH EXTRACTS METALS ANALYSES WITH LEACHATE METALS ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZE

Parameter	Samples (in µg/L)							Standards/Criteria (in µg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate[c]	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Arsenic	ND	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Barium	205-530	355-496	173-228	161-458	222-408	302-408	2,970-3,080	100,000	1,000	SNA
Cadmium	17-117	ND	352-724	29-349	301-685	ND	ND	1,000	10	SNA
Chromium	ND	ND	19-86	ND	141-289	ND	ND	5,000	50	SNA
Copper	76-274	123-325	484-5,170	5-119	12-1,030	88-391	ND	SNA	SNA	1,000
Iron	ND-142	ND	36,600-82,000	ND	81,500-162,000	ND	7,480-10,500	SNA	SNA	300
Lead	22-85	ND	7,580-15,400	ND-169	4,110-8,840	ND-115	ND	5,000	50	SNA
Manganese	618-1,560	ND	2,740-4,910	364-4,060	3,070-3,970	ND	17,100-18,500	SNA	SNA	50
Mercury	ND-6.3	ND-0.96	ND-0.65	ND	0.27-2.1	0.22-1.0	ND	200	2	SNA
Selenium	ND	ND	ND	ND	ND	ND	ND	1,000	10	SNA
Silver	ND	ND	ND	ND	ND	ND	ND	5,000	50	SNA
Sodium	64,400-85,600	58,500-82,700	66,200-83,600	1,400,000-1,590,000	66,800-86,200	53,200-68,000	2,430,000-2,470,000	SNA	SNA	SNA
Zinc	2,450-9,850	20-91	48,000-82,400	222-16,300	36,900-82,700	41-192	27-70	SNA	SNA	5,000
Aluminum Oxide	ND-52	4,570-47,400	46,800-150,000	ND-159	104,000-152,000	1,960-50,500	ND	SNA	SNA	SNA
Calcium Oxide	914,000-1,200,000	343,000-538,000	1,920,000-2,100,000	1,340,000-1,730,000	1,990,000-2,200,000	352,000-475,000	5,570,000-5,670,000	SNA	SNA	SNA
Magnesium Oxide	36,900-47,800	100-188	74,900-103,000	37,600-61,000	89,000-116,000	59-170	14,800-15,000	SNA	SNA	SNA
Potassium Monoxide	38,000-57,700	35,800-61,200	37,300-69,800	34,500-59,400	35,500-64,400	34,400-46,400	1,430,000-1,450,000	SNA	SNA	SNA
Silicon Dioxide	19,800-32,400	1,170-3,990	46,800-65,700	5,050-12,300	120,000-136,000	911-3,770	470-498	SNA	SNA	SNA

ND Not Detected
SNA Standard Not Available.

(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.
(c) Results for aluminum, calcium, magnesium, potassium, and silicon are for metals and not oxides.

TABLE 6-10

COMPARISON OF ASH EXTRACTS CONVENTIONAL ANALYSES WITH LEACHATE CONVENTIONAL ANALYSES
RANGES OF CONCENTRATIONS
FACILITY ZE

Parameter	Samples (in mg/L)							Standards/Criteria (in mg/L)		
	CO_2 Extracts	DI H_2O Extracts	EP TOX Extracts	TCLP 1 Extracts	TCLP 2 Extracts	SAR Extracts	Leachate	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Ammonia-Distilled (as N)	0.24-0.38	0.20-0.46	0.36-0.61	0.21-0.46	0.26-0.50	3.72-4.11	9.78-11.4	SNA	SNA	SNA
Total Organic Carbon	NA	16.3-23.3	NA	NA	NA	14.9-24.9	25.5-28.9	SNA	SNA	SNA
Chloride	341-709	317-702	328-583	342-818	334-693	NA	NA	SNA	SNA	250
Sulfate	635-919	140-190	719-926	891-1,230	883-1,090	NA	309-312	SNA	SNA	250
Solids, Dissolved @ 180°C	NA	1,120-1,690	NA	NA	NA	NA	25,900-26,300	SNA	SNA	500
Total Alkalinity	NA	162-234	NA	NA	NA	NA	95.2-117	SNA	SNA	SNA
Nitrate (as N)	0.39-1.23	0.08-0.17	0.17-0.22	0.11-0.21	0.13-0.18	NA	0.01	SNA	10	SNA
Orthophosphate	ND	ND	0.12-1.04	ND-0.02	0.75-1.99	ND	ND	SNA	SNA	SNA
Extract's Initial pH	4.72-5.18	11.27-11.52	11.04-11.32	5.01-5.08	3.42-3.60	11.37-11.75	NA	SNA	SNA	SNA
Extract's Final pH	6.77-7.17	10.99-11.50	4.95-5.09	7.10-8.18	4.51-4.63	10.87-11.38	NA	SNA	SNA	SNA

NA	Not analyzed due to differences in scope of work.
ND	Not Detected.
SNA	Standard Not Available.
(a)	Primary Drinking Water Standards.
(b)	Secondary Drinking Water Standards.

7

7.0 SUMMARY OF RESULTS

This section presents a summary of the data presented in Sections 2.0 through 6.0. It also compares the data generated during this present study with data reported in a previous EPA sponsored study (EPA, October 1987).

7.1 CHEMICAL CHARACTERIZATION OF ASH

Table 7-1 presents the results of the Appendix IX semivolatile analyses for the ash samples from each facility. The data in this table indicate that phthalates were found in the ash samples from each MWC facility, except for Facility ZE, and that two PAHs were detected in the ash from Facility ZD.

Table 7-2 compares the range of concentrations of semivolatile compounds found in the combined fly/bottom ash from this study with the range of concentrations found in fly ash, and bottom ash reported in the literature, as summarized in a previous report (EPA, October 1987). The data in this table indicate that fewer compounds were found in the ash during this present study as compared to the data provided in the literature. The concentrations of the compounds which were found in this study are generally similar to those reported in the literature.

Table 7-3 presents the results of the PCDD/PCDF analyses of the ash samples from each facility. This table also presents the Toxicity Equivalency Factor (TEF) for each PCDD/PCDF homolog, the Toxicity Equivalency (TE) for each homolog calculated according to EPA's Methodology (EPA, March 1987), and a Total TE for each sample. Although PCDDs/PCDFs were detected in each ash sample, the levels found were below the Centers for Disease Control (CDC) recommended upper level of 2,3,7,8-TCDD Toxicity Equivalency of 1 part per billion in residential soils (Kimbrough, 1984).

Table 7-4 compares the ranges of concentrations of PCDDs/PCDFs found in ash samples during this study with the ranges of concentrations of PCDDs/PCDFs reported in the literature and summarized in a previous report (EPA, October 1987). The data in this table indicate that the levels of PCDDs/PCDFs found in the ash during this present study are generally lower than the range of PCDDs/PCDFs found in other ash samples, as reported in the literature.

Table 7-4 also presents the range of concentrations of PCBs in fly ash, bottom ash, and combined ash. The data in this table indicate that only Dichloro Biphenyl was found in the ash during this present study.

Table 7-5 presents the range of results of the metals analyses for the ash from each facility. Metals showing the widest range of concentration among samples collected at each facility included barium (ZB); cadmium (ZB); chromium (ZD, ZE); copper (ZA, ZB, ZC); lead (ZD); manganese (ZA, ZC); mercury (ZE); zinc (ZB, ZD, ZE) and silicon dioxide (ZA).

Metals showing the widest variation of concentrations between the facilities included barium (results for Facility ZC are lower than the results for the other facilities); iron (results for each facility vary from all of the other facilities); lead (results for Facility ZD are higher than the results for the other facilities); mercury (results for Facilities ZC and ZD are lower than the results for the other facilities); sodium (results for Facilities ZD and ZE are lower than the results for the other facilities); calcium oxide (the results for Facilities ZA and ZB are higher than the results for the other facilities); and silicon dioxide (the results for Facility ZC are higher than the results for the other facilities).

Table 7-6 compares the ranges of concentrations of metals found in the ash during this study with the ranges of concentrations of metals found in fly ash, bottom ash, and combined ash as reported in the literature and summarized in a previous report (EPA, October 1987). The data in this table indicate that the results obtained during this study are generally similar to the previous results.

Several compounds (aluminum, cadmium, calcium, mercury, and potassium) exhibited higher levels during this study than those reported previously for combined ash. The levels of copper found during this study are higher than the results reported previously for combined ash, but are still lower than the results reported previously for bottom ash. The magnesium results reported in this study are higher than the results reported previously for all three types of ash. However, the results for magnesium are close to those previously reported. The levels of silicon found in the ash during this study are much higher than the levels found in previous studies.

Table 7-7 presents the range of results of the conventional analyses for the ash from each facility. Compounds showing the widest range of values between samples at each facility included TOC (ZA, ZB, ZD, ZE); ammonia (ZA, ZB, ZE); nitrate (ZC, ZD); total alkalinity (ZB, ZC, ZE); chloride (ZB, ZD); sulfate (ZB, ZD); and total soluble solids (ZE).

Compounds showing the widest variation between facilities included TOC (results for Facilities ZD and ZE are higher than the results for the other facilities); total soluble salts (results for Facilities ZA and ZB are higher than the results for the other facilities); ammonia (results for Facilities ZC and ZD are lower than the results for the other facilities); total alkalinity (results for Facility ZA are higher than the results for the other facilities); chloride (results for Facilities ZA and ZB are higher than the results for the other facilities); and sulfate (results for Facility ZC are higher than the results for the other facilities).

7.2 CHEMICAL CHARACTERIZATION OF LEACHATES

Table 7-8 presents the range of results of the Appendix IX semivolatile analyses for the leachate samples from each facility. The data in this table indicate that phenols were detected in the leachate from the ashfill serving MWC Facility ZA and that benzoic acid was detected in the leachate from the ashfill serving MWC Facility ZE.

Table 7-9 compares the ranges of concentrations of the semivolatile compounds found in the leachates in this study with the ranges of concentrations of organic compounds reported in the literature and summarized in a previous report (EPA, October 1987). The data in this table indicate that very few semivolatile compounds were found in the leachates during this study. The levels of phenol detected in the leachates during this study are much lower than the levels of phenol found in the leachates from the MSW landfills or co-disposal sites.

Table 7-10 presents the range of concentrations of PCDDs/PCDFs found in the leachate samples from each facility. PCDDs/PCDFs were only found at extremely low levels in the leachates from the ashfill for Facility ZA.

Table 7-11 compares the ranges of concentrations of PCDDs/PCDFs found in the leachates during this study with the ranges of concentrations of PCDDs/PCDFs found in leachates during a previous study (EPA, October 1987). The data in this table indicate that the leachates did not contain significant quantities of PCDDs/PCDFs. The data in this table also indicate that the homologs most often found in leachates from ash monofills are the more highly chlorinated homologs (HpCDD, HpCDF, OCDD, OCDF) which are also the homologs with the relatively lower Toxicity Equivalency Factors (TEFs).

Table 7-12 presents the results of the metals analyses of the leachate from each facility. For comparison, this table also presents the EP Toxicity Maximum Allowable Limit, and the Primary and Secondary Drinking Water standards established under the Safe Drinking Water Act (EPA: BNA, June 1989 and EPA: BNA, October 1988). The data in this table indicate that all of the metals were below their EP Toxicity Maximum Allowable Limit. The data in this table also indicate that, although the leachates are not used for drinking purposes, the majority of the metals results met the Primary or Secondary Drinking Water Standards.

Table 7-13 compares the ranges of concentrations of metals in the leachates from this study with the ranges of concentrations of metals in leachates found in the literature and summarized in a previous NUS report (EPA, October 1987). The data in this table indicate that the EP Toxicity Maximum Allowable Limits were not exceeded by the leachates from ash monofills in either this study or in the previous NUS report. The data in this table also indicate that a number of compounds are reported as having higher concentrations in the leachates from this study than the leachates from the previous study.

Table 7-14 presents the range of results of the conventional analyses for the leachate from each facility. Sulfate values ranged from 14.4 mg/L to 5,080 mg/L, and TDS values ranged from 924 mg/L to 41,000 mg/L.

7.3 CHEMICAL CHARACTERIZATION OF ASH EXTRACTS

The only Appendix IX semivolatile compound detected in the deionized water extracts (SW-924) was benzoic acid, which ranged from below the detection limits to 130 μg/L. Table 7-15 compares the ranges of concentrations of semivolatile compounds found in the deionized water ash extracts (SW-924) during this study with the ranges of concentrations of organics found in ash extracts from a previous report (EPA, October 1987). All studies show that MWC ash extracts are generally free of semivolatile compounds.

Table 7-16 compares the ranges of concentrations of the metals analyses of the ash extracts found during this study with the ranges of concentrations of metals analyses of extracts as reported in the literature and summarized in a previous NUS report (EPA, October 1987). The data in this table indicate that the extracts from the EP Toxicity, the TCLP 1, and the TCLP 2 extraction procedures contained generally higher levels of metals than the extracts from the other extraction procedures.

The data in this table also indicate that the extracts from the deionized water extraction procedure (SW-924), both from this study and from the literature, and the extracts from the CO_2 and the SAR extraction procedures meet the EP Toxicity Allowable Limits. The extracts from the EP Toxicity, TCLP 1, and the TCLP 2 extraction procedures occasionally exceeded the EP Toxicity Maximum Allowable Limits for some metals.

For the facilities sampled during this study, the data indicate that the extracts from the deionized water (SW-924), the CO_2, and the SAR extraction procedures simulated the concentrations for lead and cadmium in the field leachates better than the extracts from the other three extraction procedures.

TABLE 7-1

COMPARISON OF ASH SEMIVOLATILE RESULTS

Parameter	Samples (µg/kg)				
	ZA-AH-003	ZB-AH-001	ZC-AH-003	ZD-AH-003	ZE-AH-003
Bis(2-ethylhexyl) phthalate	250,000	810JB	310JB	390JB	ND
Di-n-octyl phthalate	2,000T	ND	ND	ND	ND
Di-n-butyl phthalate	430JB	ND	400JB	270JB$_1$	ND
Fluoranthene	ND	ND	ND	170J	ND
Phenanthrene	ND	ND	ND	310J	ND

ND	Not detected.
J	Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limits.
B	Laboratory identified compound as not being detected substantially above the level reported in laboratory blanks. Laboratory may be the source of the compound.
B$_1$	Compound was identified during data validation as not being detected substantially above the level reported in the laboratory blanks. Laboratory may be the source of the contamination.
T	The mass spectrum does not meet EPA CLP criteria for confirmation, but compound presence is strongly suspected.

TABLE 7-2

RANGES OF CONCENTRATIONS OF SEMIVOLATILES IN FLY ASH, BOTTOM ASH, AND COMBINED ASH FROM MUNICIPAL WASTE INCINERATORS

Constituent	Range, Fly Ash (ppb)	Range, Bottom Ash (ppb)	Range, Combined Ash (ppb)
Naphthalene	270-9,300	570-580	ND
Biphenyl	2-1,300	NR	ND
Acenaphthylene	ND-3,500	37-390	ND
Anthracene	1-500	53	ND
Fluorene	0-100	ND-150	ND
Phenanthrene	21-7,600	500-540	ND-310J
Di-n-butyl phthalate	ND	360	ND-430JB
Fluoranthene	0-6,500	110-230	ND-170J
Pyrene	0-5,400	150-220	ND
Butyl benzyl phthalate	ND	180	ND
Chrysene	0-690	ND-37	ND
Bis(2-ethylhexyl)phthalate	85	2,100	ND-250,000
Benzanthrene	0-300	NR	ND
Benzo(k)fluoranthene	ND-470	ND-51	ND
Benzo(a)pyrene	ND-400	ND-5	ND
Benzo(g,h,i)perylene	0-190	ND	ND
Diethyl phthalate	6,300	NR	ND
Acenaphthene	NR	28	ND
Normal alkanes	50,000	NR	ND
Chlorobenzenes	80-4,220	17	ND
Chlorophenols	50.1-9,630	0	ND
Di-n-octyl phthalate	NR	NR	ND-2,000T
Country	USA, Canada, Japan and The Netherlands	USA and Canada	USA

ND Not detected.
NR Not reported in the literature.
J Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limits.
B Laboratory identified compound as not being detected substantially above the level reported in laboratory blanks. Laboratory may be the source of the compound.
T The mass spectrum does not meet EPA CLP criteria for confirmation, but compound presence is strongly suspected.

Source: Fly ash and bottom ash ranges are from "Characterization of MWC Ashes and Leachates from MSW Landfills, Monofills, and Co-Disposal Sites," EPA 530-SW-87-028A, October 1987. Combined Ash ranges are from this study.

TABLE 7-3

ASH DIOXIN RESULTS

Compound	Toxicity Equivalency Factor (TEF)(1)	Samples (pg/g or ppt)									
		ZA-AH-003		ZB-AH-001		ZC-AH-003		ZD-AH-003		ZE-AH-003	
		Value	Toxicity Equivalents	Value	Toxicity Equivalents	Value	Toxicity Equivalents	Value	Toxicity Equivalents	Value	Toxicity Equivalents
2,3,7,8-TCDD	1	10	10	24	24	16	16	35	35	10	10
Other TCDD	0.01	206	2.06	351	3.51	281	2.81	541	5.41	120	1.2
2,3,7,8-TCDF	0.1	263	26.3	617	61.7	236	23.6	626	62.6	176	17.6
Other TCDF	0.001	1,688	1.69	3,721	3.72	1,208	1.21	2,633	2.63	1,136	1.14
1,2,3,7,8-PeCDD	0.5	33	16.5	118	59	71	35.5	ND	0	35	17.5
Other PeCDD	0.005	317	1.59	759	3.80	1,051	5.26	1,910	9.55	248	1.24
1,2,3,7,8-PeCDF	0.1	61	6.1	194	19.4	64	6.4	151	15.1	52	5.2
2,3,4,7,8-PeCDF	0.1	46	4.6	162	16.2	56	5.6	171	17.1	43	4.3
Other PeCDF	0.001	484	0.484	1,527	1.53	607	0.607	1,736	1.74	448	0.448
1,2,3,4,7,8-HxCDD	0.04	12	0.48	40	1.6	66	2.64	86	3.44	11	0.44
1,2,3,6,7,8-HxCDD	0.04	17	0.68	34	1.36	90	3.6	148	5.92	11	0.44
1,2,3,7,8,9-HxCDD	0.04	28	1.12	79	3.16	120	4.8	194	7.76	22	0.88
Other HxCDD	0.0004	154	0.062	342	0.137	925	0.37	853	0.34	104	0.042
1,2,3,4,7,8-HxCDF	0.01	74	0.74	336	3.36	218	2.18	654	6.54	95	0.95
1,2,3,6,7,8-HxCDF	0.01	131	1.31	524	5.24	279	2.79	660	6.60	134	1.34
1,2,3,7,8,9-HxCDF	0.01	36	0.36	127	1.27	193	1.93	479	4.79	45	0.45
2,3,4,6,7,8-HxCDF	0.01	5	0.05	54	0.54	70	0.70	124	1.24	20	0.20
Other HxCDF	0.0001	281	0.0281	939	0.0939	635	0.0635	1,686	0.169	280	0.028
1,2,3,4,6,7,8,-HpCDD	0.001	159	0.159	319	0.319	1,849	1.85	1,555	1.56	122	0.122
Other HpCDD	0.00001	140	0.0014	288	0.00288	1,511	0.0151	1,384	0.0138	0	0
1,2,3,4,6,7,8-HpCDF	0.001	139	0.139	539	0.539	653	0.653	1,842	1.84	155	0.155
1,2,3,4,7,8,9-HpCDF	0.001	8	0.008	48	0.048	83	0.083	119	0.119	16	0.016
Other HpCDF	0.00001	51	0.00051	197	0.00197	254	0.00254	384	0.00384	44	0.00044
OCDD	0	313	0	544	0	6,906	0	4,519	0	294	0
OCDF	0	66	0	243	0	563	0	893	0	59	0
Total TEs			74.5		211		119		189		63.7

(1) Toxicicty Equivalency Factors are EPA's current recommended factors (EPA, March 1987).
ND Not detected below 221 pg/g.

TABLE 7-4

RANGES OF CONCENTRATIONS OF PCDDs, PCDFs, and PCBs IN FLY ASH, BOTTOM ASH, AND COMBINED ASH FROM MUNICIPAL WASTE INCINERATORS

Constituent	Range, Fly Ash (ppb)	Range, Combined Ash (Literature) (ppb)	Range, Bottom Ash (ppb)	Range, Combined Ash (CORRE) (ppb)
Mono CDD	2.0	NR	ND	NA
Di CDD	0.4-200	NR	ND	NA
Tri CDD	1.1-82	NR	ND	NA
Tetra CDD	ND-250	0.14-14	<0.04-0.65	0.130-0.576
Penta CDD	ND-722	1.9-50	ND-3	0.283-1.91
Hexa CDD	ND-5,565	1.4-78	ND-2.3	0.148-1.28
Hepta CDD	ND-3,030	1.4-120	ND-6.3	0.122-3.36
Octa CDD	ND-3,152	0.84-89	ND-29	0.294-6.91
2,3,7,8-TCDD	0.1-42	0.02-0.78	<0.04-0.7	0.010-0.035
Total Poly CDD	5.23-10,883	6.2-350	ND-110	RNR
Mono CDF	41	NR	1.1	NA
Di CDF	ND-90	NR	0.63	NA
Tri CDF	0.7-550	NR	ND	NA
Tetra CDF	ND-410	2.3-91	0.15-1.4	1.31-4.34
Penta CDF	ND-1,800	1.6-37	0.07-6.2	0.543-2.06
Hexa CDF	Tr-2,353	1.2-35	ND-2.5	0.527-3.6
Hepta CDF	Tr-666	0.62-36	ND-6.9	0.198-2.345
Octa CDF	ND-362	0.18-8.4	ND-3.7	0.059-0.893
2,3,7,8-TCDF	0.1-5.4	0.41-12	ND-10	0.176-0.626
Total Poly CDF	3.73-3,187	6.14-153.9	ND-65	RNR

TABLE 7-4
RANGES OF CONCENTRATIONS OF PCDDs, PCDFs, and PCBs FROM MUNICIPAL WASTE INCINERATORS (ppb)
PAGE TWO

Constituent	Range, Fly Ash (ppb)	Range, Combined Ash (Literature) (ppb)	Range, Bottom Ash (ppb)	Range, Combined Ash (CORRE) (ppb)
Mono CB	0.29-9.5	ND	ND-1.3	ND
Di CB	0.13-9.9	0.126-1.35	ND-5.5	98-107
Tri CB	ND-25	0.35-14.3	ND-80	ND
Tetra CB	0.5-42	16.5-16.5	ND-47	ND
Penta CB	0.87-225	ND	ND-48	ND
Hexa CB	0.45-65	NR	ND-39	ND
Hepta CB	ND-0.1	NR	ND	ND
Octa CB	ND-1.2	NR	ND	ND
Nona CB	ND	NR	ND	ND
Deca CB	ND	NR	ND	ND
Total PCB	ND-250	ND-32.15	ND-180	ND
Country	USA, Canada, W. Germany, The Netherlands, Japan	USA	USA, Canada, Japan	USA

NA	Not analyzed.
ND	Not detected.
NR	Not reported in the literature.
RNR	Results not reported in this manner. 2,3,7,8-TCDD toxicity equivalents were calculated and are reported in Table 7-3.
Tr =	0.01<Tr<0.1 ng/g.
Source:	Results in first three columns are from "Characterization of MWC Ashes and Leachates from MSW Landfills, Monofills, and Co-Disposal Sites," EPA, October 1987. Results in last column are from this study.

TABLE 7-5

ASH METALS ANALYSES
RANGES OF CONCENTRATIONS

Parameter	Samples				
	ZA-AH-001 - ZA-AH-005	ZB-AH-001 - ZB-AH-005	ZC-AH-001 - ZC-AH-005	ZD-AH-001 - ZD-AH-005	ZE-AH-001- ZE-AH-005
METALS	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)	(mg/kg)
Arsenic	37-51	28-56	28-36	30-54	15-20
Barium	436-554	260-1,000	193-331	411-545	391-792
Cadmium	32-56	52-152	42-52	39-69	18-38
Chromium	55-93	53-118	45-57	52-199	67-665
Copper	946-7,360	674-9,330	524-4,470	959-1,800	930-1,820
Iron	44,100-63,300	13,600-22,200	20,000-25,000	22,900-37,100	33,900-45,100
Lead	1,180-1,820	1,070-1,740	1,710-2,630	2,860-22,400	1,170-1,600
Manganese	587-1,360	508-846	518-1,200	574-965	531-640
Mercury	10.4-25.1	7.7-12	1.1-3.2	0.55-2.10	3.2-13.0
Selenium	ND	ND-5.7	ND	ND-3.9	ND-4.7
Silver	4.1-8.7	5.4-10.0	5.6-12	6.3-11.0	4.4-13.0
Sodium	9,350-11,000	8,200-10,600	7,370-8,940	5,890-6,500	5,880-7,770
Zinc	4,310-6,900	4,360-15,800	4,110-7,170	4,260-8,000	2,120-8,280
METAL OXIDES	(%)	(%)	(%)	(%)	(%)
Aluminum Oxide	8.52-9.85	7.39-10.3	5.93-8.64	9.9-13.0	9.7-11.0
Calcium Oxide	15.1-22.2	19.4-25.7	9.70-11.4	10.0-12.0	13.0-15.0
Magnesium Oxide	1.21-1.50	1.19-1.62	1.02-1.30	1.8-2.2	1.6-2.0
Potassium Monoxide	1.10-1.24	0.827-0.941	0.875-1.07	0.79-1.4	0.95-1.4
Silicon Dioxide	21.9-43.8	19.0-29.4	48.4-62.9	32.0-37.0	30-35

ND Not Detected.

TABLE 7-6

RANGES OF CONCENTRATIONS OF INORGANIC CONSTITUENTS IN FLY ASH, COMBINED ASH, AND BOTTOM ASH FROM MUNICIPAL WASTE INCINERATORS

Parameter	Fly Ash (ppm)	Combined Bottom and Fly Ash (Literature) (ppm)	Bottom Ash (ppm)	Combined Bottom and Fly Ash (CORRE) (ppm)
Arsenic	15-750	2.9-50	1.3-24.6	15-56
Barium	88-9,000	79-2,700	47-2,000	193-1,000
Cadmium	<5-2,210	0.18-100	1.1-46	18-152
Chromium	21-1,900	12-1,500	13-520	45-665
Lead	200-26,600	31-36,600	110-5,000	1,070-22,400
Mercury	0.9-35	0.05-17.5	ND-1.9	0.55-25.1
Selenium	0.48-15.6	0.10-50	ND-2.5	ND-5.7
Silver	ND-700	0.05-93.4	ND-38	4.1-13.0
Aluminum	5,300-176,000	5,000-60,000	5,400-53,400	5.93-13.0(1)
Antimony	139-760	<120-<260	NR	NA
Beryllium	ND-<4	0.1-2.4	ND-<0.44	NA
Bismuth	36-<100	NR	ND	NA
Boron	35-5,654	24-174	85	NA
Bromine	21-250	NR	NR	NA
Calcium	13,960-270,000	4,100-85,000	5,900-69,500	9.7-25.7(1)
Cesium	2,100-12,000	NR	NR	NA
Cobalt	2.3-1,670	1.7-91	3-62	NA
Copper	187-2,380	40-5,900	80-10,700	524-9,330
Iron	900-87,000	690-133,500	1,000-133,500	13,600-63,300
Lithium	7.9-34	6.9-37	7-19	NA
Magnesium	2,150-21,000	700-16,000	880-10,100	1.02-2.2(1)
Manganese	171-8,500	14-3,130	50-3,100	508-1,360
Molybdenum	9.2-700	2.4-290	29	NA
Nickel	9.9-1,966	13-12,910	9-226	NA

TABLE 7-6
RANGES OF CONCENTRATIONS OF INORGANIC CONSTITUENTS IN FLY ASH, COMBINED ASH, AND BOTTOM ASH FROM MUNICIPAL WASTE INCINERATORS
PAGE TWO

Parameter	Fly Ash (ppm)	Combined Bottom and Fly Ash (Literature) (ppm)	Bottom Ash (ppm)	Combined Bottom and Fly Ash (CORRE) (ppm)
Phosphorus	2,900-9,300	290-5,000	3,400-17,800	NA
Potassium	11,000-65,800	290-12,000	920-13,133	0.79-1.4(1)
Silicon	1,783-266,000	NR	1,333-188,300	19.0-62.9(1)
Sodium	9,780-49,500	1,100-33,300	1,800-33,300	5,880-11,000
Strontium	98-1,100	12-640	81-240	NA
Tin	300-12,500	13-380	40-800	NA
Titanium	<50-42,000	1,000-28,000	3,067-11,400	NA
Vanadium	22-166	13-150	53	NA
Yttrium	2-380	0.55-8.3	NR	NA
Zinc	2,800-152,000	92-46,000	200-12,400	2,120-15,800
Gold	0.16-100	NR	NR	NA
Chloride	1,160-11,200	NR	NR	766-44,200
Country	USA, Canada	USA	USA, Canada	USA

(1) Results are for oxides and are expressed as percents.
NA Not analyzed, as it was not part of the scope of work for this project.
ND Not detected.
NR Not reported in the literature.
Source: The results in the first three columns are from "Characterization of MWC Ashes and Leachates from MWS Landfills, Monofills, and Co-Disposal Sites," EPA 530-SW-87-028A, October 1987. The results in the last column are from this study.

TABLE 7-7

ASH CONVENTIONAL ANALYSES RANGES OF CONCENTRATIONS

Parameter	Samples (mg/kg)				
	ZA-AH-001-ZA-AH-005	ZB-AH-001-ZB-AH-005	ZC-AH-001-ZC-AH-005	ZD-AH-001-ZD-AH-005	ZE-AH-001-ZE-AH-005
Ammonia-Distilled (as N)	2.89-11.5	3.69-10.6	1.33-2.10	0.90-1.08	2.77-8.69
Total Organic Carbon	11,400-35,600	14,600-29,600	9,020-17,800	11,400-53,200	4,060-43,300
Chloride	16,300-23,700	18,600-44,200	3,870-5,860	766-2,190	7,550-14,100
Sulfate	3,770-6,100	764-3,130	5,900-10,300	1,680-5,580	1,500-2,790
Solids, Dissolved @ 180°C	46,500-52,400	36,700-65,800	22,000-26,100	6,440-13,200	11,200-35,500
Total Alkalinity	7,540-8,100	1,590-6,650	1,210-3,040	558-922	2,990-7,590
Nitrate (as N)	2.22-4.23	1.45-2.87	0.09-6.46	0.44-1.59	2.9-4.51
Orthophosphate	ND	ND	ND	ND-0.05	ND
pH	11.68-11.85	10.91-11.67	11.58-11.82	10.36-10.69	11.4-11.82

ND Not Detected.

TABLE 7-8

LEACHATE SEMIVOLATILE RESULTS
RANGES OF CONCENTRATIONS

Parameter	Samples (µg/L)				
	ZA-LE-001-ZA-LE-007	ZB-LE-001	ZC-LE-001-ZC-LE-002	ZD-LE-001-ZD-LE-003	ZE-LE-001-ZE-LE-002
Benzoic acid	ND	ND	ND	ND	52-73
Phenol	2J-32	ND	ND	ND	ND
3-Methylphenol	ND-6J	ND	ND	ND	ND
4-Methylphenol	ND-6J	ND	ND	ND	ND

ND Not Detected.
J Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limit.

TABLE 7-9

CONCENTRATIONS OF ORGANIC CONSTITUENTS IN LEACHATE FROM MUNICIPAL WASTE LANDFILLS, ASH MONOFILLS, AND CO-DISPOSAL SITES

Constituent	Range (Literature) (µg/L)	NUS Municipal (µg/L)	NUS Codisposal (µg/L)	Ash Monofill (CORRE) (µg/L)
Acetone	140-11,000	4-4,600	ND-1,500	NA
Benzene	2-6,080	ND	ND	NA
Benzoic Acid	NR	NR	NR	ND-73
Bromomethane	10-170	ND	ND	NA
1-Butanol	50-360	ND	ND	NA
Carbon tetrachloride	2-398	ND	ND	NA
Chlorobenzene	2-237	ND	ND	NA
Chloroethane	5-860	ND	ND	NA
Bis(2-chloroethoxy)methane	2-25	ND	ND	ND
Chloroform	2-1,300	ND	ND	NA
Chloromethane	10-170	ND	ND	NA
Delta BHC	0-5	ND	ND	NA
Dibromomethane	5-25	ND	ND	NA
1,4-Dichlorobenzene	2-37	ND	ND	ND
Dichlorodifluoromethane	10-450	ND	ND	NA
1,1-Dichloroethane	2-6,300	ND	ND	NA
1,2-Dichloroethane	0-11,000	ND-16	ND	NA
Cis-1,2-Dichloroethene	4-190	ND	ND	NA
Trans-1,2-Dichloroethene	4-2,760	ND	ND	NA
Dichloromethane	2-3,300	ND	ND	NA
1,2-Dichloropropane	2-100	ND-230	ND	NA
Diethyl phthalate	2-330	ND	ND	ND
Dimethyl phthalate	4-55	ND	ND	ND
Di-n-butyl phthalate	4-150	ND-23	ND	ND
Endrin	0-1	ND	ND-250	NA
Ethyl acetate	5-50	ND	ND	NA
Ethyl benzene	5-4,900	ND	ND-15	NA
Bis(2-ethylhexyl)phthalate	6-150	ND	ND	ND

TABLE 7-9
CONCENTRATIONS OF ORGANIC CONSTITUENTS IN LEACHATE FROM MUNICIPAL WASTE LANDFILLS, ASH MONOFILLS, AND CO-DISPOSAL SITES
PAGE TWO

Constituent	Range (Literature) (µg/L)	NUS Municipal (µg/L)	NUS Codisposal (µg/L)	Ash Monofill (CORRE) (µg/L)
Isophorene	10-16,000	ND	ND	ND
Methyl ethyl ketone	110-28,000	290-12,000	ND-2,200	NA
Methyl isobutyl ketone	10-660	ND	ND	NA
3-Methylphenol	NR	NR	NR	ND-6J
4-Methylphenol	NR	NR	NR	ND-6J
Napthalene	4-68	ND	ND	ND
Nitrobenzene	2-120	ND	ND	ND
4-Nitrophenol	17-40	ND	ND	ND
Pentachlorophenol	3-470	ND	ND	ND
Phenol	10-28,800	ND-2,100	ND-2,100	ND-32
2-Propanol	94-10,000	ND	ND	NA
1,1,2,2-Tetrachloroethane	7-210	ND	ND	NA
Tetrachloroethene	2-620	ND	ND	NA
Tetrahydrofuran	5-260	ND	ND	NA
Toluene	2-3,200	ND-1,100	ND-120	NA
Toxaphene	0-5	ND-16	ND	NA
1,1,1-Trichloroethane	0-2,400	ND	ND	NA
1,1,2-Trichloroethane	2-500	ND	ND	NA
Trichloroethene	1-1,120	ND	ND	NA
Trichlorofluoromethane	4-100	ND-230	ND	NA
Vinyl chloride	0-110	ND	ND	NA
m-Xylene	21-79	ND	ND	NA
p-Xylene and o-Xylene	12-50	ND-23	ND-290	NA

NA Not analyzed, as it was not part of the scope of work for this study.
NR Not reported in the literature.
ND Not detected.
J Indicates approximate value because contaminants were detected at levels below Method Detection Limits, but above the instrument detection limit.

Source: The first three columns are from "Characterization of MWC Ashes and Leachates From MSW Landfills, Monofills, and Co-Disposal Sites," EPA, October 1987. The last column is from this study.

TABLE 7-10

LEACHATE DIOXIN RESULTS
RANGES OF CONCENTRATIONS

Parameter	Samples (ppb)				
	ZA-LE-001-ZA-LE-007	ZB-LE-001	ZC-LE-001-ZC-LE-002	ZD-LE-001-ZD-LE-003	ZE-LE-001-ZE-LE-002
2,3,7,8-TCDD	ND	ND	ND	ND	ND
TCDD-TOT	ND	ND	ND	ND	ND
PeCDD	ND	ND	ND	ND	ND
HXCDD	ND	ND	ND	ND	ND
HPCDD	ND-0.222	ND	ND	ND	ND
OCDD	ND-0.107	ND	ND	ND	ND
2,3,7,8-TCDF	ND	ND	ND	ND	ND
TCDF-TOT	ND	ND	ND	ND	ND
PeCDF	ND	ND	ND	ND	ND
HXCDF	ND	ND	ND	ND	ND
HPCDF	ND-0.076	ND	ND	ND	ND
OCDF	ND	ND	ND	ND	ND
2,3,7,8-TCDD(1) Equivalency ppb	2×10^{-4}	ND	ND	ND	ND

ND Not Detected.

(1) 2,3,7,8-TCDD equivalency calculated using Toxicity Equivalency Factors currently recommended by EPA (EPA, March 1987).

TABLE 7-11

CONCENTRATIONS OF PCDDs/PCDFs IN LEACHATES FROM ASH MONOFILLS RANGES OF CONCENTRATIONS

Compound	Field Leachate Monofill B (ppb)	Field Leachate Monofill C (ppb)	Field Leachate Monofill D (ppb)	Field Leachate Facility ZA (ppb)
2,3,7,8-TCDD	<0.06-0.28	<0.05-1.6	<0.22-<0.26	ND
Total TCDD	<0.06-6.6	<0.05-28	0.13-0.27	ND
Total PeCDD	<0.05-25	<0.03-93	<0.22-0.4	ND
Total H$_X$CDD	<0.02-22	<0.02-130	2.1-2.2	ND
Total H$_p$CDD	0.009-21	<0.02-172	8.2-8.8	ND-0.222
Total OCDD	0.14-14	0.06-120	23-25	ND-0.107
Total Dioxin	0.149-88.6	0.06-543	33.93-36.17	NR
2,3,7,8-TCDF	<0.05-3.7	<0.08-11	0.37-0.4	ND
Total TCDF	<0.05-22	<0.08-65	2.9-3	ND
Total PeCDF	<0.02-17	<0.02-64	2.3-2.4	ND
Total H$_X$CDF	<0.01-16	<0.01-76	1.9-1.9	ND
Total H$_p$CDF	0.05-9.4	<0.03-60	1.2-1.3	ND-0.076
Total OCDF	0.05-1.9	0.04-15	0.81-0.84	ND
Total Furan	0.1-66.3	0.04-280	9.21-9.34	NR
2,3,7,8-TCDD (1) Equivalency (µg/kg or µg/L)	0.000-0.037	0.000-0.062	0.000-0.001	2×10^{-4}

ND Not detected.

NR Not reported, since the results were reported in another fashion.

(1) 2,3,7,8-TCDD equivalency calculuated using Toxicity Equivalency Factors currently recommended by EPA (EPA, March 1987).

Source: The results for Monofill B, Monofill C, and Monofill D are from "Characterization of MWC Ashes and Leachates from MSW Landfills, Monofills and Co-Disposal Sites," EPA, October 1987. The results from Facility ZA are from this study.

TABLE 7-12

LEACHATE METALS ANALYSES
RANGES OF CONCENTRATIONS

Parameter	Samples (in µg/L)					Standards/Criteria (in µg/L)		
	ZA-LE-001-ZA-LE-007	ZB-LE-001	ZC-LE-001-ZC-LE-002	ZD-LE-001-ZD-LE-003	ZE-LE-001-ZE-LE-002	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act(a) MCLs	Safe Drinking Water Act(b) SMCLs
Arsenic	47-400	ND	ND	ND	ND	5,000	50	SNA
Barium	ND	9,220	7.8-8.0	18-40	2,970-3,080	100,000	1,000	SNA
Cadmium	ND-1.7	4.0	ND	ND	ND	1,000	10	SNA
Chromium	ND-32	ND	ND	ND	ND	5,000	50	SNA
Copper	ND	8.8	ND	4.6-12	ND	SNA	SNA	1,000
Iron	120-3,400	840	108-115	187-523	7,480-10,500	SNA	SNA	300
Lead	8-54	ND	ND-34	ND	ND	5,000	50	SNA
Manganese	310-4,600	17,600	493-501	718-857	17,100-18,500	SNA	SNA	50
Mercury	ND	ND	ND	ND	ND	200	2	SNA
Selenium	24-340	ND	ND	ND	ND	1,000	10	SNA
Silver	ND	ND	ND	ND	ND	5,000	50	SNA
Sodium	3,000,000-3,800,000	2,450,000	188,000-191,000	1,340,000-2,580,000	2,430,000-2,470,000	SNA	SNA	SNA
Zinc	60-370	8.3	9-13	5.2-8.7	27-70	SNA	SNA	5,000
Aluminum	700-920	ND	ND	ND	ND	SNA	SNA	SNA
Calcium	3,270,000-5,360,000	8,390,000	64,600-65,800	386,000-477,000	5,570,000-5,670,000	SNA	SNA	SNA
Magnesium	51,000-70,000	17,300	22,600-23,000	340,000-367,000	14,800-15,000	SNA	SNA	SNA
Potassium	516,000-525,000	1,620,000	79,700-81,200	229,000-636,000	1,430,000-1,450,000	SNA	SNA	SNA
Silicon	2,100-5,700	3,150	4,570-4,840	8,760-15,300	470-498	SNA	SNA	SNA

ND Not Detected.
SNA Standard Not Available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 7-13

RANGES OF LEACHATE CONCENTRATIONS OF INORGANIC CONSTITUENTS FROM MONOFILLS

Constituent	Concentration (Literature) (mg/L)	Concentration (CORRE Study) (mg/L)	EP Toxicity Maximum Allowable Limit (mg/L)	Primary Drinking Water Standard (mg/L)
Arsenic	0.005-0.218	ND-0.400	5.0	0.050
Barium	1.0	ND-9.22	100.0	1.000
Cadmium	ND-0.044	ND-0.004	1.0	0.010
Chromium	0.006-1.53	ND-0.032	5.0	0.050
Lead	0.012-2.92	ND-0.054	5.0	0.050
Mercury	0.001-0.008	ND	0.2	0.002
Selenium	0.0025-0.037	ND-0.340	1.0	0.010
Silver	0.07	ND	5.0	0.050
Aluminum	NR	ND-0.920	SNA	SNA
Beryllium	NR	NA	SNA	SNA
Boron	NR	NA	SNA	SNA
Calcium	21	64.6-8,390	SNA	SNA
Cobalt	NR	NA	SNA	SNA
Copper	0.022-24	ND-0.012	SNA	SNA
Iron	0.168-121	0.108-10.5	SNA	SNA
Lithium	NR	NA	SNA	SNA
Magnesium	NR	14.8-367	SNA	SNA
Manganese	0.103-4.57	0.310-18.5	SNA	SNA
Molybdenum	NR	NA	SNA	SNA
Nickel	ND-0.412	NA	SNA	SNA
Potassium	21.5	79.7-1,620	SNA	SNA
Sodium	200-4,000	188-3,800	SNA	SNA
Strontium	NR	NA	SNA	SNA
Tin	NR	NA	SNA	SNA
Silicon	NR	0.470-15.3	SNA	SNA

TABLE 7-13
RANGES OF LEACHATE CONCENTRATIONS OF INORGANIC CONSTITUENTS FROM MONOFILLS
PAGE TWO

Constituent	Concentration (Literature) (mg/L)	Concentration (CORRE Study) (mg/L)	EP Toxicity Maximum Allowable Limit (mg/L)	Primary Drinking Water Standard (mg/L)
Titanium	NR	NA	SNA	SNA
Vanadium	NR	NA	SNA	SNA
Yttrium	NR	NA	SNA	SNA
Zinc	ND-3.3	0.0052-0.370	SNA	SNA
Chloride	1,803-18,500	7,700-22,000	SNA	SNA
Sulfate	94	14.4-5,080	SNA	SNA
pH	8.04-8.3	5.2-7.4	SNA	SNA
TDS	11,300-28,900	924-41,000	SNA	SNA

ND Not detected.
NR Not reported in the literature.
NA Not analyzed, as it was not part of the scope of work for this study.
SNA Standard Not Available.
Source: First column is from "Characterization of MWC Ashes and Leachates from MSW Landfills, Monofills, and Co-Disposal Sites," EPA, October 1987. Second column is from this study.

TABLE 7-14

LEACHATE CONVENTIONAL ANALYSES RANGES OF CONCENTRATIONS

Parameter	Samples (in mg/L)					Standards/Criteria (in mg/L)		
	ZA-LE-001- ZA-LE-007	ZB-LE-001	ZC-LE-001- ZC-LE-002	ZD-LE-001- ZD-LE-003	ZE-LE-001- ZE-LE-002	EP Toxicity Maximum Allowable Limit	Safe Drinking Water Act[a] MCLs	Safe Drinking Water Act[b] SMCLs
Ammonia-Distilled (as N)	5.3-35	4.18	68.2-77.4	4.38-28.4	9.78-11.4	SNA	SNA	SNA
Total Organic Carbon	17-420	30	47.2-49.3	28.8-30.7	25.5-28.9	SNA	SNA	SNA
pH (field) (standard units)	6.7-7.4	6.5	6.9	NR	5.2	SNA	SNA	SNA
Sulfate	620-1,500	171	14.4-14.5	4,140-5,080	309-312	SNA	SNA	250
Solids, Dissolved @ 180°C	13,700-41,000	40,600	924-932	8,030-13,000	25,900-26,300	SNA	SNA	500
Total Alkalinity	44-120	65	560-566	709-744	95.2-117	SNA	SNA	SNA
Nitrate (as N)	ND-0.2	0.45	0.40-0.41	ND-0.04	0.01	SNA	10	SNA
Orthophosphate	0.18-1.2	0.01	ND	0.17-0.24	ND	SNA	SNA	SNA
Specific Conductivity	33,000-46,000 µmhos/cm	>10,000 µmhos/cm	1,800 µmhos/cm	9,400->10,000 µmhos/cm	>10,000	SNA	SNA	SNA
Chloride	7,700-22,000	NA	NA	NA	NA	SNA	SNA	250
Temperature (°C) (field)	NA	9	21	19-30	23	SNA	SNA	SNA
Kjeldahl Nitrogen	34-43	NA	NA	NA	NA	SNA	SNA	SNA

NA Not analyzed, due to differences in scope of work.
ND Not detected
NR Not reported; pH meter not working properly.
SNA Standard not available.
(a) Primary Drinking Water Standards.
(b) Secondary Drinking Water Standards.

TABLE 7-15

RANGES OF EXTRACT CONCENTRATIONS OF ORGANIC CONSTITUENTS FROM MUNICIPAL WASTE INCINERATOR COMBINED FLY ASH AND BOTTOM ASH FOR THREE LEACHING PROCEDURES

Constituents	Range of Concentrations (ppm)				
	Deionized Water Extraction Procedure (Literature)		Extraction Procedure Test (Literature)	Toxic Characteristic Leaching Procedure (Literature)	Deionized Water Extraction Procedure (CORRE)
	First Extraction	Second Extraction			
Naphthalene	ND	ND	ND-8	ND	ND
Methyl naphthalene	ND-0.080	ND	ND-18	ND	ND
Oleyl Alcohol(1)	ND-0.088	ND	ND	ND	ND
Methoxy ethane(2)	ND	ND	ND	ND	ND
Methoxy ethanol	ND	ND-0.006	ND	ND-0.013	ND
Dimethyl propdiol(3)	ND-0.160	ND-0.140	ND-0.190	ND-0.140	ND
Phenol	ND	ND-0.033	ND	ND	ND
Bis oxy ethanol(4)	ND-0.096	ND-0.018	ND	ND	ND
Ethoxy ethanol(5)	ND-0.310	ND-0.390	ND	ND	ND
Cycloocta decone(6)	ND-0.580	ND-1.2	ND	ND	ND
M. Furan dione(7)	ND	ND	ND	ND	ND
E. Dim dioxane(8)	ND-0.510	ND	ND	ND	ND
Benz, Di carboxy A	ND	ND-0.002	ND	ND	ND
Benzoic acid	NR	NR	NR	NR	ND-0.130

ND Not detected.
NR Not reported in the literature.
Source: "Characterization of MWC Ashes and Leachates From MWS Landfills, Monofills, and Co-Disposal Sites," EPA, October 1987. Last column are the results of this study.

(1) (2)-9 Octadecen-1-01 (CAS 143-28-2).
(2) 1-Methoxy-2-(methoxy methoxy)ethane (9C1) (CAS 74498-88-7).
(3) 2,2-Dimethyl-1,3-propanedial (CAS 162-30-7).
(4) 2,2-{1,2-Etharediylbis (oxy) bis-}ethanol (CAS 112-27-6).
(5) (2)-9 Octadecer-1-01 (CAS 143-28-2).
(6) 1,4,7,10,13,16-Hexaoxa cycloocta decane (CAS 17455-13-9).
(7) 3,4-Dimethyl-2,5-furadione (9C1) (CAS 766-39-2).
(8) 5-Ethyl-2,2-dimethyl-1,3,-dioxane (9C1) (CAS 25796-26-3).

TABLE 7-16

ASH EXTRACTS METALS ANALYSES
RANGES OF CONCENTRATIONS
COMPARISON OF LITERATURE VALUES WITH RESULTS OBTAINED DURING CORRE STUDY

Parameter	Samples (in µg/L)											Standards/Criteria (in µg/L)
	SW-924 (DI H_2O) (Literature)	DI H_2O Extracts (CORRE)	EP TOX Extracts (Literature)	EP TOX Extracts (CORRE)	TCLP Extracts (Literature)	TCLP 1 Extracts (Literature)	TCLP 2 Extracts (Literature)	TCLP 1 Extracts (CORRE)	TCLP 2 Extracts (CORRE)	CO_2 Extracts	SAR Extracts	EP Toxicity Maximum Allowable Limit
Arsenic	5-50	ND-45	5-100	ND-31	5-37	10-30	10-100	ND	ND-60	ND-53	ND	5,000
Barium	150-390	139-3,050	27-6,300	23-455	NR	100-3,200	50-630	161-1,850	12-809	126-530	129-3,960	100,000
Cadmium	5-30	ND-7.6	10-3,940	25-1,200	25-3,320	30-1,900	10-470	ND-1,150	ND-1,560	ND-354	ND-6.0	1,000
Chromium	2.5-20	ND-16	5.9-460	ND-86	25-439	200-320	10-160	ND-8.0	ND-799	ND-9.8	ND-10	5,000
Copper	2.5-190	12-534	39-1,190	24-5,170	2.5-19	50-90	20-20	5-858	5.4-1,400	8.8-620	8.5-610	SNA
Iron	2.5-38	ND-115	4,500-143,000	ND-82,000	828-60,600	183,000-230,000	2,180-6,330	ND-7,220	ND-162,000	ND-304	ND-97	SNA
Lead	25-2,980	ND-3,410	20-34,000	ND-19,700	655-30,100	900-47,000	50-6,100	ND-10,500	ND-26,400	ND-504	ND-3,940	5,000
Manganese	ND-10	ND-20	3,600-6,240	250-8,540	4,200-11,900	7,040-7,470	3,220-3,340	ND-5,170	3.8-7,370	ND-2,390	ND-6.4	SNA
Mercury	10-100	ND-0.96	ND-6,000	ND-203	4-4	50-60	ND-100	ND-3.8	ND-4.6	ND-155	ND-1.1	200
Selenium	2.5-50	ND	2-100	ND	2.5-25	10-10	10-50	ND	ND	ND	ND-23	1,000
Silver	ND-50	ND	1-100	ND	NR	20-40	10-50	ND	ND	ND-16	ND	5,000
Sodium	68,300-85,300	24,100-209,000	89,900-100,000	33,600-225,000	NR	103,000-110,000	1,410,000-1,500,000	1,380,000-1,640,000	38,700-228,000	24,800-168,000	24,200-201,000	SNA
Zinc	1.5-960	5.4-1,340	38,500-726,000	67-95,600	23,300-373,000	72,200-83,200	23,500-32,000	9.7-79,500	26-164,000	5-127,000	12-1,290	SNA
Aluminum Oxide	170-29,400	ND-203,000	31,900-43,800	ND-150,000	NR	30,800-32,800	90-90	ND-62,800	ND-152,000	ND-90,700	ND-118,000	SNA
Calcium Oxide	122,000-536,000	141,000-1,740,000	77,000-1,740,000	592,000-4,810,000	NR	1,930,000-1,990,000	362,000-1,430,000	666,000-2,750,000	692,000-3,640,000	398,000-1,920,000	142,000-1,800,000	SNA
Magnesium Oxide	ND-190	21-379	22,800-42,700	27,300-130,000	NR	41,700-41,800	140-27,900	55-375,000	623-137,000	207-59,300	12-430	SNA
Potassium Monoxide	85,200-120,000	13,100-189,000	10,000-154,000	10,100-189,000	NR	106,000-111,000	86,500-93,900	14,600-210,000	15,100-1,110,000	12,300-155,000	14,500-181,000	SNA
Silicon Dioxide	NR	402-3,990	NR	5,090-98,700	NR	NR	NR	379-51,700	820-143,000	418-71,800	364-3,770	SNA

ND	Not detected.
NR	Not reported in the literature.
SNA	Standard not available.

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REFERENCES

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APPENDICES

A

APPENDIX A

FINAL WORK PLAN

NUS
CORPORATION
WASTE MANAGEMENT SERVICES GROUP

PARK WEST TWO
CLIFF MINE ROAD
PITTSBURGH, PA 15275-1071
(412) 788-1080

FINAL
WORK PLAN

U.S. EPA AND
THE COALITION ON RESOURCE RECOVERY AND THE ENVIRONMENT (CORRE)

NUS PROJECT NUMBER

DECEMBER 1988

SUBMITTED FOR NUS BY:

Haia Roffman
HAIA ROFFMAN
PROJECT MANAGER

TABLE OF CONTENTS

SECTION **PAGE**

1.0 INTRODUCTION 1-1

2.0 DETAILED SCOPE OF WORK 2-1
- 2.1 FIELD SAMPLING 2-1
- 2.1.1 Sampling Procedures 2-1
- 2.1.1.1 Sample Collection 2-1
- 2.1.2 Sample Numbering 2-4
- 2.1.3 Sample Documentation 2-4
- 2.1.4 Sample Handling 2-5
- 2.1.5 Sample Packaging and Shipping 2-5
- 2.1.6 Equipment Decontamination 2-6
- 2.2 SAMPLE HANDLING AND PREPARATION 2-6
- 2.2.1 Ash Sample Preparation 2-7
- 2.2.2 Extraction Sample Preparation 2-7
- 2.2.3 Field Leachate Analysis 2-9

3.0 SAMPLE ANALYSES 3-1

4.0 DATA EVALUATION AND ANALYSIS 4-1

5.0 REPORTS 5-1

6.0 SCHEDULE 6-1

APPENDICES

A CARBON-DIOXIDE-SATURATED DEIONIZED WATER AND SIMULATED ACID RAIN EXTRACTION SOLUTIONS AND EXTRACTION PROCEDURES A-1

B PCDD/PCDF AND PCB ANALYTICAL PROCEDURES AND QA/QC PROTOCOLS B-1

TABLES

NUMBER		PAGE
1-1	Sampling and Analysis Summary	1-2
2-1	Analytical Parameters, Containers, and Preservatives	2-3
2-2	Sample Preparation and Chemical Analysis by Laboratories	2-8

1.0 INTRODUCTION

This work plan has been prepared for the United States Environmental Protection Agency (EPA) and the Coalition on Resource Recovery and the Environment (CORRE) in response to a jointly-sponsored EPA and CORRE study to characterize the composition of municipal waste combustion (MWC) ashes and associated leachates from the corresponding monofills.

The objective of this study is to collect ash samples from five MWC facilities and subject them to laboratory analysis and several laboratory extractions, as well as to collect natural leachates from the MWC Ash Monofills in which these ashes are disposed. Results of this study will enhance the data base on the characteristics of MWC ashes, extracts, and leachates from MWC ash monofills. The data obtained in this study must be of high quality, from the perspective of both sampling and chemical analysis. Table 1-1 provides a summary of the number of samples to be taken and the types of analyses to be performed.

This phase of the project concentrates on five MWC facilities. Additional facilities may be added to the study at a later date by the study sponsors.

All information obtained throughout this study, including the identification of the facilities participating in this study, will be treated with utmost confidentiality. Only selected NUS personnel will have access to the data. Except for these selected NUS project team members, no one, including the EPA sponsors of the study, will have access to the data. All project data will be kept in a secure locked file or work area at all times. Access to this area will be strictly limited.

Section 2.0 of this work plan addresses the scope of work. Recommendations included in the EPA publication entitled "Sampling and Analysis of Municipal Refuse Incineration Ash" will be adhered to. Section 3.0 describes the analytical protocols; Section 4.0 delineates data validation and evaluation; Section 5.0 describes the content of the draft and final reports to be produced; and Section 6.0 addresses the study schedule.

TABLE 1-1

SAMPLING AND ANALYSIS SUMMARY
CORRE

Sampling			Types of Analysis
Number of Facilities	Number of Samples per Facility	Total Number of Samples	
I. MWC TOTAL ASH			
5	5(3)	25	Metals(1) and conventionals(2)
2	1(3)	2	PCBs
5	1(3)	5	PCDDs/PCDFs
5	1(3)	5	Semivolatiles (Appendix IX)
II. MWC ASH EXTRACTS			
5	5(3)	150	Metals(1) and conventionals(2) utilizing the extraction procedures listed in Section 2.2.2
5	1(3)	5(4)	Semivolatiles and PCDDs/PCDFs
2	1(3)	2(4)	PCBs
III. FIELD LEACHATES			
4	2	8	Metals(1) and conventionals(2)
1	2	2	PCBs
4	2	8	PCDDs/PCDFs
4	2	8	Semivolatiles

(1) Includes metals on primary and secondary drinking water standard lists and others as follows: As, Ba, Cd, Cr, Pb, Hg, Se, Ag, Na, Cu, Fe, Mn, and Zn; Al, Si Ca, Mg, K.

(2) Includes the following conventional parameters: TOC, total soluble salts, NH_3–N, NO_3–N, SO_4, PO_4, CO_3, Cl, and pH.

(3) Each sample represents a composite of 8 individual samples collected per day.

(4) A composite of the extracts from only one extraction procedure will be analyzed for semivolatiles, PCDDs/PCDFs and PCBs. The extraction procedure to be chosen will be determined at a later date based on results obtained for metals and conventional parameters.

2.0 DETAILED SCOPE OF WORK

This section provides the program elements for sampling and analysis of MWC ashes from five facilities and MWC Ash Monofill leachates from four facilities. It also provides the scope of work for data evaluations and interpretation, reporting, and the QA/QC elements necessary for ensuring a meaningful program.

It is assumed in this Work Plan that the five MWC facility and associated MWC Ash Monofill sites will be selected by CORRE. Site locations and a contact person at each facility will be identified by CORRE and provided to NUS.

2.1 FIELD SAMPLING

The purpose of this task is to perform the actual collection of leachate from four MWC Ash Monofills and ash samples from five MWC facility sites, document the sampling, and handle and ship the samples in accordance with the following procedures.

2.1.1 Sampling Procedures

2.1.1.1 Sample Collection

Leachate Sample Collection

Four MWC facilities will be chosen for leachate sampling. Leachates will be collected from the leachate collection system of the MWC Ash Monofill. Two samples will be collected at each of the four facilities for laboratory analysis of metals, conventional parameters, PCDDs/PCDFs, and Appendix IX semivolatiles. Two samples collected from only one facility will be analyzed for PCBs.

Leachate samples will be taken from the collection system as grab samples. Candidate sampling locations include collection sumps and/or drainage ditches. The NUS onsite person will select the sampling points in cooperation with facility personnel. Preferably, the samples will be collected by submerging the sample containers. Alternatively, they will be collected using stainless-steel buckets attached to an aluminum handle or a polyethylene rope.

All sample containers will be filled to capacity to prevent oxidation and precipitation of dissolved metals.

Samples destined for metal analyses will be filtered in the field prior to acidification, if possible. If impracticable to filter in the field, samples will not be acidified in the field but only cooled and instructions sent to the laboratory (VERSAR) to filter and acidify upon receipt of sample.

All samples destined for semivolatile analyses (Appendix IX), PCDDs/PCDFs and PCBs if found to be turbid, will be centrifuged by the analyzing laboratories (VERSAR and BATTELLE) prior to being extracted for analysis. Only the liquid will be analyzed. Instructions to centrifuge will be sent from the field with the applicable samples by the NUS Sampler.

Leachate sampling will be performed by NUS personnel. Table 2-1 lists the number of samples, analytical parameters, containers, and preservatives applicable to collection of the leachate samples. These samples will be analyzed for metals and conventional parameters, PCDDs, PCDFs, and Appendix IX semivolatile compounds. One sample per site from only two facilities will be analyzed for PCBs.

MWC Ash Sample Collection

Five ash composite samples will be collected at five MWC facilities. Ash samples will be collected from a conveyor. Sampling will be performed by facility personnel. An NUS sampling expert will be on site during the ash sampling.

The following procedures will be employed during ash sampling:

- Samples will be collected with a shovel.
- Grab samples will be taken from the conveyor using "ASTM D2234-86 Standard Methods for Collection of a Gross Sample of Coal," Condition B, full-stream cut.
- Collection will be done at a fixed point each hour for 8 hours.

TABLE 2-1

ANALYTICAL PARAMETERS, CONTAINERS, AND PRESERVATIVES
CORRE

Number of Samples	Type of Analysis	Container(s)[1]	Preservative[2]
SOURCE: MWC MONOFILL LEACHATE			
8	Metals[3]	One 1-liter polyethylene	HNO_3 to $pH < 2$
8	TOC, NH_3-N	One 1-liter polyethylene	H_2SO_4 to $pH < 2$
8	TDS, NO_3–N, SO_4, PO_4	One 1-liter polyethylene	
8	CO_3	One 500-mL polyethylene	HNO_3 to $pH < 2$
2	PCBs	Two 1/2-gallon amber glass	
8	PCDDs/PCDFs	Two 1/2-gallon amber glass	
8	Semivolatiles (Appendix IX)	Two 1/2-gallon amber glass	
SOURCE: MWC ASH			
200[5]	Metals[3], semivolatiles (Appendix IX), PCDDs/PCDFs/PCBs, and conventional[4] parameters in ash and in ash extractions listed in Section 2.2.2	1 quart	

(1) All containers will have Teflon-lined, screw-on lids.

(2) All samples will be cooled to 4°C.

(3) As, Ba, Cd, Cr, Pb, Hg, Se, Ag, Na, Cu, Fe, Mn, and Zn; Oxides Al, Si, Ca, Mg, K.

(4) TOC, total soluble salts, NH_3–N, NO_3–N, SO_4, PO_4, CO_3, Cl, and pH.

(5) The 200 samples will be grouped as 8-hour composites yielding a total of 25 samples. Two of the 25 composite samples extractions will also be analyzed for PCBs and 5 will be analyzed for PCDDs/PCDFs and semivolatiles (Appendix IX).

- The eight samples will be scooped into a 5-gallon container and will be composited into an 8-hour composite sample. The container will be sealed, labeled, and stored for shipment at the end of the 5 days of sampling. Sample handling and shipping will be done by NUS personnel.

- Samples will be collected each day over 5 days of facility operation. Starting time for sample collection will be one 1 hour later each day. For example, Monday sample collection will begin at 8:00 a.m., Tuesday at 9:00 a.m., etc.

Table 2-1 lists the number of samples, analytical parameters, containers, and preservatives for the leachate and ash samples.

2.1.2 Sample Numbering

All samples will be assigned a field identification number to include codes for the site name, sample type, and station number. The site name may be abbreviated using a two- or three-letter code, such as ML. The sample type will be denoted as either LE, for leachate samples, or AH, for ash samples. The station number will refer to a specific sampling location, if applicable.

Additional codes will be utilized for identifying the first hour of ash sampling and the date. The date will be noted by two digits for the month, day, and the year; the hour of day will be designated by four digits. For example, an ash sample collected at the first location on December 20, 1988, at 10:00 a.m., would be designated as follows:

- ML-AH-001
- 12-20-88-1000

2.1.3 Sample Documentation

All site activity and sampling will be documented in a waterproof, bound, log book to be completed by the NUS onsite personnel. Additionally, the following documents will be prepared to track each sample through shipping and analysis:

- Sample labels - One per sample container; information on the label will include date, time, sample number, analysis, and preservative.

- Traffic report forms - Individual forms for each individual laboratory.

- Chain-of-custody forms - One per sample shipment to an individual laboratory.

- Chain-of-custody seals - Two per cooler, affixed so that the cooler cannot be opened without breaking the seals.

- Airbills - One per sample shipment to an individual laboratory.

2.1.4 Sample Handling

All liquid samples will be placed on ice in a cooler immediately after collection. Required preservatives for the liquid samples will be added as soon as possible after collection. The subsequent list of procedures will then be followed:

- Complete proper decontamination.
- Tighten and secure the lid of each container.
- Seal each container in a watertight plastic bag.

Samples will be shipped the day they are collected via a qualified carrier for next-day delivery. Ash samples will be shipped to the VERSAR laboratory upon completion of sampling at each facility.

2.1.5 Sample Packaging and Shipping

To ensure that the laboratories will receive enough sample volume, all samples will be treated as environmental samples. The following steps will be taken during packaging and shipping:

- Plug the drain and line the cooler with a large, impervious plastic sheet.

- Place samples in the cooler.

- Include several watertight ice packs.

- Fill with a light, absorbent, packing material such as vermiculite.

- Place laboratory copies of sample documentation in a sealed plastic bag and tape to the cooler lid.

- Affix custody seals.

- Secure the cooler with strapping tape.

- The traffic report forms will indicate whether the field team believes that a sample is of medium concentration.

2.1.6 Equipment Decontamination

Dedicated disposable or laboratory-cleaned equipment will be used to collect all samples. After use, any nondisposable equipment, such as a shovel, will be decontaminated using the following steps, as applicable:

- Tap water and laboratory-grade soap wash
- Tap water rinse
- 10 percent nitric acid solution rinse
- DI water rinse
- Solvent rinse
- DI water rinse
- Air dry
- Foil wrapping and storage in a secure area

2.2 SAMPLE HANDLING AND PREPARATION

Samples collected during the field sampling will consist of two basic types of media: field leachate and MWC ash samples.

All field leachate samples except those to be analyzed for PCBs and PCDDs/PCDFs will be shipped to VERSAR. Samples to be analyzed for PCBs and PCDDs/PCDFs will be shipped to Battelle Columbus.

2.2.1 Ash Sample Preparation

All field MWC ash samples will be sent to VERSAR. VERSAR will prepare these samples for analysis by implementing the following procedures:

- Each composite will be passed over a 2-inch screen. Material passing the 2-inch screen will be set aside. Material larger than 2 inches will be subjected to repeated blows with a 5-pound sledge hammer dropped from a height of 1 foot. If a piece does not break after being subjected to three blows of the hammer, it will be weighed, the weight recorded, and discarded. Material that breaks will then be reduced in size to pass the 2-inch screen and recombined with the original material smaller than 2 inches.

- Each composite sample will be dried, crushed to pass a 3/8-inch screen and riffled or coned and quartered to obtain a 1,000-gram sample. The sample will then be properly labeled and stored in a clean, dry, cool, secure area. For further details, see ASTM Standard D346.

Selected portions of five leachate extractions for each of the extraction methodologies will be sent to Battelle Columbus for PCDD/PCDF and PCB analysis. Table 2-2 summarizes the analysis by laboratories.

2.2.2 Extraction Sample Preparation

VERSAR will extract ash samples using six different extraction methods, as follows:

- Acid No. 1 (EP-TOX)
- Acid No. 2 (TCLP Fluid No. 1)
- Acid No. 2 (TCLP Fluid No. 2)
- Method 924
- CO_2 saturated deionized water
- Simulated acid rain

The laboratory will adhere to the appropriate Federal Register leaching requirements for the first four methods. The extraction solutions and the extraction procedures for the CO_2 saturated deionized water and the simulated acid rain are given in Appendix A.

TABLE 2-2

SAMPLE PREPARATION AND CHEMICAL ANALYSIS BY LABORATORIES
CORRE

Sample Media	Preparation	Analysis*
MWC Total Ash	VERSAR	VERSAR: Metals,* Conventionals,* Semivolatiles** BATTELLE COLUMBUS: PCBs, PCDDs/PCDFs
MWC Ash Extractions	VERSAR	VERSAR: Metals, Conventionals, Semivolatiles BATTELLE COLUMBUS: PCBs, PCDDs/PCDFs
Field Leachates	VERSAR	VERSAR: Metals, Conventionals, Semivolatiles BATTELLE COLUMBUS: PCBs, PCDDs/PCDFs

* See footnotes to Table 2-1 for detailed individual analyses of metals and conventional parameters.

** Appendix IX.

VERSAR will analyze the extracts for metals, conventional parameters, and the semivolatile compounds on the Appendix IX list and will ship the selected extract samples to Battelle Columbus for PCB, PCDF, and PCDD analyses.

2.2.3 Field Leachate Analysis

Leachate samples collected from the field will be analyzed for metals, conventional parameters, and semivolatile compounds by VERSAR and for PCBs and PCDDs/PCDFs by Battelle Columbus.

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3.0 SAMPLE ANALYSES

All analyses except for PCBs, PCDD/PCDFs, and conventional parameters will be conducted in strict adherence to the EPA third edition of SW-846 and will include all deliverables specified by the applicable method.

The conventional parameters will be analyzed according to the applicable methods described in the "Methods for Chemical Analysis of Water and Wastewaters," EPA-600/4-79-020, March 1983.

PCBs, PCDDs, and PCDFs will be analyzed in the homolog form according to the procedures described in Appendix B. In addition, for the PCDDs and PCDFs the concentrations of the individual 2, 3, 7, 8 isomers will be determined for each homolog.

4.0 DATA EVALUATION AND ANALYSIS

Results obtained from the laboratories will be validated, according to EPA national validation guidelines; evaluated; and interpreted. The data will be compiled into a single data base.

Results of laboratory analyses will be validated by qualified NUS chemists, according to QA standards established by EPA. The data validation is independent of internal validation performed by the laboratories involved, and is intended to assure high quality data.

The validated data will be compiled into a single data base. These data will be compared with literature information and with Applicable or Relevant and Appropriate Requirements (ARARs). Attempts will be made to evaluate the environmental effects of the ashes and the leachates.

Operating data for the sampled facilities during the sampling period will be provided, as available, from the facility personnel.

5.0 REPORTS

NUS will prepare a draft report, which will contain the following descriptions:

- MWC facilities sampled. Facility identification will be kept in confidence, and only codes will be used.
- MWC ash monofills sampled. Facility location will be limited to identification by codes only.
- Sampling procedures.
- Analytical procedures.
- Results.
- Evaluation of results.

The draft report will be submitted for review by EPA and CORRE. A final report will be issued upon receipt of comments from EPA and CORRE.

EPA and CORRE may provide a list of three potential peer reviewers who will be given the opportunity to comment on the draft report. The peer reviewer's comments will also be incorporated in the final report.

APPENDIX A

CARBON-DIOXIDE-SATURATED DEIONIZED WATER AND SIMULATED ACID RAIN EXTRACTION SOLUTIONS AND EXTRACTION PROCEDURES

CO_2 SATURATED ELUANT

The intent of this eluant formation is to simulate a relatively "natural" low pH rainwater without the use of atmospheric man-made contaminants common such as HC1 and SO_4.

Step 1 One must develop a "pH-time of purging" relationship curve. This is done simply by plotting observed pH to delta time during purge of distilled water with compressed CO_2. Pursuant to Henry's gas law (attached text) an equilibrium of CO_2 at controlled ambient temperature in liquid from gas will be reached--at this time pH and time of purge should be recorded and thereafter used as a reference for preparing the CO_2 saturated distilled water solutions.

Step 2 After obtaining the reference pH and CO_2 time, use the prepared eluant per SW-846 procedures.

SYNTHETIC ACID RAIN ELUANT

The intent of this eluant formation is to simulate an acid rain representative of the Northeastern United States according to the National Atmosphere Deposition Program (NADP) quality reference.

Step 1 Prepare the following primary solution

Parameter	Units
Distilled water	4 liters
$NaNO_3$	0.1150 grams (gm)
KNO_3	0.2196 gm
NH_4NO_3	0.648 gm
$MgC1_2$	0.0821 gm
H_2SO_4	0.1755 gm of [98 percent]
$CaSO_4$	0.1057 gm

Step 2 To achieve a more reasonable pH representative of the Northeast, dilute the solution prepared in Step 1 by ten (10) fold.

Step 3 Utilize the eluant prepared form Step 2 pursuant to SW-846 procedures.

the pure component, the conditions are favorable for phase separation. Phase separation occurs when the Gibbs energy of the two-phase system is lower than that of the homogeneous system. Figure 3.9*d* shows the type of phase diagram that results if the positive deviations from Raoult's law are so large that there is a range of immiscibility of the two liquids.

It is important to notice that in all of these four diagrams the vapor pressure of the component present at higher concentration approaches the values given by Raoult's law as its mole fraction approaches unity. Other types of deviations from Raoult's law are also found. A component may show positive deviations in dilute solutions and negative deviations in concentrated solutions or vice versa.[*]

Solutions that exhibit a maximum or a minimum in the vapor pressure curves exhibit a minimum or a maximum in the boiling point curves. When a boiling point curve has a maximum or a minimum, the solutions having the maximum or minimum boiling points are called azeotropes. These solutions distill without change in composition because the liquid and the vapor have the same composition. Many examples of azeotropic solutions are known.[†] At 1 atm, ethanol, which boils at 78.3 °C, and water form a minimum-boiling azeotrope that boils at 78.174 °C and contains 4.0% water by weight. Hydrochloric acid, which boils at −80 °C, and water form a maximum-boiling azeotrope at 108.584 °C that contains 20.222% HCl by weight.

3.15 HENRY'S LAW

In all the examples shown in Fig. 3.9 there is a region at low concentration where the partial pressure of the solute (the component at low concentration) is directly proportional to its mole fraction.

$$\boxed{P_2 = X_2 K_2} \tag{3.61}$$

The subscript 2 indicates that the solute is being considered. This equation is referred to as Henry's law, and the constant K_2 is referred to as the Henry's law constant. In dilute solutions the environment of the minor component is constant, and its escaping tendency is proportional to its mole fraction. For nonideal solutions Henry's law holds for the solute in the same range where Raoult's law holds for the solvent. For ideal solutions $K_2 = P_2^*$ and Henry's law becomes identical with Raoult's law.

The value of the Henry's law constant K_2 is obtained by plotting the ratio P_2/X_2 versus X_2 and extrapolating to $X_2 = 0$. Such a plot is shown later in Fig. 3.11.

It is convenient to express the solubilities of gases in liquids by use of Henry's law constants. A few gas solubilities at 25 °C are summarized in this way in Table 3.2.

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[*] M. L. McGlashan, *J. Chem. Ed.*, 40, 516 (1963).

[†] L. H. Horsley and co-workers, *Azeotropic Data*, Advances in Chemistry Series, American Chemical Society, Washington, D.C., 1952.

Up to a pressure of 1 atm Henry's law holds within 1 to 3% for many slightly soluble gases.

Table 5.2 Henry's Law Constants for Gases at 25 °C[a]

	Solvent	
Gas	Water	Benzene
H_2	5.34×10^7	2.75×10^6
N_2	6.51×10^7	1.79×10^6
O_2	3.30×10^7	
CO	4.34×10^7	1.22×10^6
CO_2	1.25×10^6	8.57×10^4
CH_4	31.4×10^6	4.27×10^5
C_2H_2	1.01×10^6	
C_2H_4	8.67×10^6	
C_2H_6	23.0×10^6	

[a] $K_2 = P_2/X_2$. The partial pressure of the gas is given in torr.

$x_2 = \frac{P_2}{K_2} = \left(\frac{760}{1.25\times10^6}\right)$ $K = \frac{P_2}{x_2} = \frac{760}{}$

Example 5.6 Using the Henry's law constant, calculate the solubility of carbon dioxide in water at 25 °C at a partial pressure of CO_2 over the solution of 760 torr. Assume that a liter of solution contains practically 1000 g of water.

$$K = \frac{P_2}{X_2} = 1.25 \times 10^6\ \text{torr} = \frac{760\ \text{torr}}{(CO_2)}\left((CO_2) + \frac{1000}{18.02}\right)$$

Since (CO_2) may be considered negligible in comparison with the number of moles of water, 1000/18.02,

$$(CO_2) = \frac{(760\ \text{torr})(55.49\ \text{mol L}^{-1})}{1.25 \times 10^6\ \text{torr}} = 3.38 \times 10^{-2}\ \text{mol L}^{-1}$$

$X_2 \rightarrow \frac{n_2}{n_1}$ $\left(\frac{g_2}{MW}\right)\frac{MW_1}{1000}$ $\times\left(\frac{1000}{18}\right)$

$\frac{n_2}{n_1 + n_2}$ $\times \frac{n_2\,MW_1}{g_1}$

The solubility of a gas in liquids usually decreases with increasing temperature, since heat is generally evolved in the solution process. There are numerous exceptions, however, especially with the solvents liquid ammonia, molten silver, and many organic liquids. It is a common observation that a glass of cold water, when warmed to room temperature, shows the presence of many small air bubbles.

The solubility of an unreactive gas is due to intermolecular attractive forces between gas molecules and solvent molecules. There is a good correlation between the solubilities of gases in solvents at room temperature and their boiling points. Substances with low boiling points (He, [illegible] N_2, Ne, etc.) have weak intermolecular attractions and are therefore not very [illegible] in liquids.

The solubility of gases in water [illegible] decreased by the addition of other solutes, particularly electrolytes. [illegible] of this "salting out" varies considerably with different salts, but [illegible] the relative decrease in solubility is nearly the same for different [illegible] lity of liquids and solids in water also shows this salting-out [illegible]

For the dissociation of an acid with a negative charge

$$\boxed{HA^{-n} = H^+ + A^{-(n+1)}} \qquad (6.6)$$

the thermodynamic dissociation constant $K_{I=0}$ is given by

$$K_{I=0} = \frac{a_{H^+}(A^{-(n+1)})y_{-(n+1)}}{(HA^{-n})y_{-n}} = K_I\frac{y_{-(n+1)}}{y_{-n}} \qquad (6.7)$$

Substituting equation 6.5 and rearranging yields

$$pK_I = pK_{I=0} - \frac{(2n+1)AI^{1/2}}{(1+I^{1/2})} \qquad (6.8)$$

Example 6.1 Estimate pK_1 and pK_2 for H_3PO_4 at 25 °C and 0.01 ionic strength.

$$pK_I = pK_{I=0} - \frac{(2n+1)(0.5091)(0.01)^{1/2}}{(1+0.01^{1/2})} = pK_{I=0} - (2n+1)0.046$$

$$pK_1 = 2.148 - 0.046 = 2.102$$
$$pK_2 = 7.198 - 3(0.046) = 7.060$$

6.3 CARBON DIOXIDE, CARBONIC ACID, AND BICARBONATE ION THERMODYNAMICS

The equilibria discussed in this section are of interest because of the importance of CO_2 in the regulation of the pH of blood. The kinetics of these reactions are discussed in Section 16.6.

Only a small fraction of the CO_2 dissolved in water is hydrated to carbonic acid.

$$\boxed{CO_2 + H_2O = H_2CO_3} \qquad (6.9)$$

The hydration constant K_h is written

$$K_h = \frac{(H_2CO_3)}{(CO_2)} \qquad (6.10)$$

At 25 °C, K_h = 0.002 58. The standard enthalpy change and the standard entropy change are both unfavorable for the hydration reaction, as shown by the values in Table 6.2; nevertheless, CO_2 has to be hydrated in order for the dissolved CO_2 produced by metabolism in our tissues to be converted to HCO_3^- and be transported to our lungs. The entropy change for reaction 6.9 is negative, because joining two molecules to form one reduces the translational and rotational degrees of freedom of the system. ΔC_P is negative because $H_2O + CO_2$ can absorb more heat per degree increase in temperature than H_2CO_3.

Carbonic acid is a somewhat stronger acid than acetic acid.

$$\boxed{H_2CO_3 = H^+ + HCO_3^-} \qquad (6.11)$$

$$K_{H_2CO_3} = \frac{(H^+)(HCO_3^-)}{(H_2CO_3)} \qquad (6.12)$$

Table 6.2 Thermodynamic Quantities at 25 °C and Zero Ionic Strength[a,b]

Equilibrium Constant	pK	$\Delta G°$	$\Delta H°$	$\Delta S°$	$\Delta C_P°$
$K_h = \frac{(H_2CO_3)}{(CO_2)}$	2.59	3,530	1,130	−8	−63
$K_{H_2CO_3} = \frac{(H^+)(HCO_3^-)}{(H_2CO_3)}$	3.77	5,170	1,010	−14	−28
$K_1 = \frac{(H^+)(HCO_3^-)}{(CO_2) + (H_2CO_3)}$	6.352	8,666	2,240	−21.6	−90
$K_2 = \frac{(H^+)(CO_3^{2-})}{(HCO_3^-)}$	10.329	14,092	3,603	−35.2	−65

[a] From J. T. Edsall, CO_2: *Chemical, Biochemical, and Physiological Aspects*, NASA SP-188, 1969.
[b] $\Delta G°$ and $\Delta H°$ in cal mol^{-1}; $\Delta S°$ and $\Delta C_P°$ in cal K^{-1} mol^{-1}.

At 25 °C, the acid dissociation constant $K_{H_2CO_3} = 1.72 \times 10^{-4}$ (pK = 3.77). However, this is not the acid dissociation constant you will find if you look in tables, and it is not the one you would use in the laboratory to do calculations on bicarbonate buffers. The reason is that in the laboratory you are not ordinarily able to distinguish between dissolved CO_2 and H_2CO_3 and simply lump these two species together by counting all dissolved CO_2 as H_2CO_3.

The first acid dissociation constant K_1 for carbonic acid is defined as

$$K_1 = \frac{(H^+)(HCO_3^-)}{(H_2CO_3) + (CO_2)} = \frac{(H^+)(HCO_3^-)}{(H_2CO_3)[1 + (CO_2)/(H_2CO_3)]} \qquad (6.13)$$

↖ all CO_2 incl as H_2CO_3

Thus

$$K_1 = \frac{K_{H_2CO_3}}{1 + 1/K_h} \qquad (6.14)$$

Calculating K_1 from the values of K_h and $K_{H_2CO_3}$ at 25 °C that are given above, we obtain $K_1 = 4.45 \times 10^{-7}$ (pK = 6.352). This is the pK you would find in titrating dissolved CO_2.

$P = \chi P_i^0$

The first dissociation of carbonic acid is of special interest because it is the primary buffer system in blood. The Henry law constant (Section 3.15) for the distribution of CO_2 between the gas and aqueous phases at 38 °C is 3.3×10^{-5} mol L^{-1} torr^{-1}. Thus, since the normal partial pressure of carbon dioxide in the alveoli of the lungs is 40 torr, the normal concentration of CO_2 in our blood is 0.0013 mol L^{-1}. The normal concentration of bicarbonate ion in our blood is 0.026 mol L^{-1}, and so equation 6.13 may be written

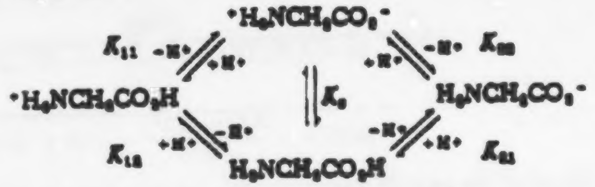
$P_i = KX_i$

$$\text{pH} = \text{p}K_1 + \log \frac{(HCO_3^-)}{(CO_2) + (H_2CO_3)} \qquad 7.4 = 6.1 + \log \frac{0.026}{0.0013} \qquad (6.15)$$

since 6.1 is the value of pK_1 at 0.15 mol L^{-1} ionic strength and $(H_2CO_3) \ll (CO_2)$. If we hyperventilate (breathe hard), reaction 6.9 shifts to the left; this causes reaction 6.11 to shift to the left and, as a result, the pH rises. If the concentration of HCO_3^- in our blood is too high, the blood pH is too high and the body increases its rate of excretion of HCO_3^- in the urine. In this way the pH of blood is maintained in the relatively narrow range of 7.0 to 7.6.

6.4 RELATION BETWEEN MICROSCOPIC DISSOCIATION CONSTANTS AND MACROSCOPIC DISSOCIATION CONSTANTS

The acid dissociations of amino acids offer interesting examples of the relations between what are called microscopic dissociation constants and macroscopic dissociation constants. Microscopic dissociation constants are defined in terms of particular ionic species and are not ordinarily accessible experimentally. In the dissociation of glycine



(6.16)

the microscopic constants are K_{11}, K_{12}, K_{21}, K_{22}, and K_z.

When glycine is titrated, we do not have information on the relative amounts of the dipolar ion, $^+H_3NCH_2CO_2^-$, and the uncharged molecule, $H_2NCH_2CO_2H$, and so we define the first acid dissociation constant K_1, a macroscopic dissociation constant, by

$$K_1 = \frac{(H^+)[(^+H_3NCH_2CO_2^-) + (H_2NCH_2CO_2H)]}{(^+H_3NCH_2CO_2H)}$$
$$= K_{11} + K_{12} = 10^{-2.35} \qquad (6.17)$$

where K_{11} and K_{12} are the microscopic dissociation constants for the two possible dissociations of a first proton. second acid-dissociation constant is given by

$$K_2 = \frac{(H^+)(H_2NCH_2CO_2^-)}{[(^+H_3NCH_2CO_2^-) + (H_2NCH_2CO_2H)]}$$

$$= \frac{1}{1/K_{22} + 1/K_{21}} = 10^{-9.78} \qquad (6.18)$$

where K_{21} and K_{22} are the microscopic dissociation constants for the two possible dissociations of a second proton. This same formulation would apply to any dibasic acid. In addition, the principle of detailed balancing (Section 15.11) yields a further relationship between the values of the four microscopic constants.

$$K_{11}K_{22} = K_{12}K_{21} \qquad (6.19)$$

Since K_1 and K_2 are known (values are given for 25 °C in Table 6.1), we need a value of only one of the four microscopic constants in order to calculate values of

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(16.16)

CO) (16.17)

it remains in
of CO_2. Since
$_3C$ $_3$ by use of

(16.18)

O) (16.19)

+ (HCO_3^-) ≈

(16.20)

Table 16.2 Half-Lives for the Hydration-Dehydration Reaction for CO_2—HCO_3^- at 25 °C

pH	$t_{1/2}$
3	0.0086 s
4	0.086
5	0.82
6	5.9
7	14.9
8	14.8
9	5.7

which corresponds to a reversible first-order reaction. As shown in Section 15.8, the *half-life* of such a reaction is given by

$$t_{1/2} = \frac{0.693}{k_f + k_r} \tag{16.21}$$

Applying this relation to the hydration of CO_2,

$$\begin{aligned} t_{1/2} &= \frac{0.693}{k_1 + k_2 K_w/(H^+) + k_{-2} + k_{-1}(H^+)/K_{H_2CO_3}} \\ &= \frac{0.693}{0.0375 + \dfrac{8.3 \times 10^{-11}}{(H^+)} + 8.06 \times 10^4 (H^+)} \end{aligned} \tag{16.22}$$

Values of the half-life calculated with this equation are given in Table 16.2. The reaction

$$OH^- + HCO_3^- \underset{1.2 \times 10^6\ s^{-1}}{\overset{6 \times 10^9 (mol\ L^{-1})^{-1}\ s^{-1}}{\rightleftharpoons}} CO_3^{2-} + H_2O \tag{16.23}$$

has to be considered at higher pH values.

16.7 ACID AND BASE CATALYSIS

Acids and bases catalyze many reactions in which they are not consumed. Suppose the rate of disappearance of a substance S (often called the substrate of the catalytic reaction) is first order in S; $-d(S)/dt = k(S)$. The first-order rate constant k for the reaction in a buffer solution may be a linear function of (H^+), (OH^-), (HA), and (A^-), where HA is the weak acid in the buffer and A^- is the corresponding anion.

$$k = k_0 + k_{H^+}(H^+) + k_{OH^-}(OH^-) + k_{HA}(HA) + k_{A^-}(A^-) \tag{16.24}$$

In this expression k_0 is the first-order rate constant at sufficiently low concentrations of all of the catalytic species H^+, OH^-, HA, and A^-. The so-called catalytic

16.6 KINETICS OF THE HYDRATION OF CO_2 AND DEHYDRATION OF H_2CO_3

In water CO_2 exists largely as dissolved CO_2 (see Section 6.3) instead of as H_2CO_3. The half-life for the hydration-dehydration reaction depends on the pH, and at neutral pH values is long enough that it may be studied with simple equipment. It is the slowness of this reaction that accounts for the fading of the endpoint when carbonate ion is titrated with acid. The half-time for this uncatalysed reaction in aqueous buffers is of special interest because it is too long to account for the process of elimination of CO_2 in our lungs. In living things this reaction is catalysed by the enzyme carbonic anhydrase so that CO_2 may be hydrated, and H_2CO_3 dehydrated, more rapidly.

In order to discuss the kinetics of the uncatalysed hydration of CO_2, it is necessary to consider the following reactions.

$$CO_2 + H_2O \underset{k_{-1} = 13.7\ s^{-1}}{\overset{k_1 = 0.0375\ s^{-1}}{\rightleftharpoons}} H_2CO_3$$

$$\underset{k_{-2} = 4.7 \times 10^{10}\ (mol\ L^{-1})^{-1}\ s^{-1}}{\overset{k_2 = 8 \times 10^{6}\ s^{-1}}{\rightleftharpoons}} H^+ + HCO_3^- \qquad (16.16)$$

$$OH^- + CO_2 \underset{k_{-3} = 1.9 \times 10^{-4}\ s^{-1}}{\overset{k_3 = 8.5 \times 10^{3}\ (mol\ L^{-1})^{-1}\ s^{-1}}{\rightleftharpoons}} HCO_3^-$$

The rate constants are for 25 °C.

The rate equation for CO_2 is

$$\frac{d(CO_2)}{dt} = -k_1(CO_2) + k_{-1}(H_2CO_3) - k_3(OH^-)(CO_2) + k_{-3}(HCO_3^-) \quad (16.17)$$

The reaction $H^+ + HCO_3^- \rightleftharpoons H_2CO_3$ occurs so rapidly that it remains in equilibrium in an experiment in which we follow the hydration of CO_2. Since HCO_3^- and H_2CO_3 remain in equilibrium, we may eliminate H_2CO_3 by use of

$$\frac{(H^+)(HCO_3^-)}{(H_2CO_3)} = K_{H_2CO_3} = 1.70 \times 10^{-4} \quad (16.18)$$

to obtain

$$\frac{d(CO_2)}{dt} = -[k_1 + k_3(OH^-)](CO_2) + [k_{-3} + k_{-1}(H^+)/K_{H_2CO_3}](HCO_3^-) \quad (16.19)$$

Since the total concentration of dissolved CO_2 is $(CO_2) + (H_2CO_3) + (HCO_3^-) \approx (CO_2) + (HCO_3^-)$, this equation has the form

$$\frac{d(A)}{dt} = -k_f(A) + k_b(B) \quad (16.20)$$

APPENDIX B

PCDD/PCDF AND PCB ANALYTICAL PROCEDURES AND QA/QC PROTOCOLS

METHOD AND QUALITY ASSURANCE
FOR
DETERMINATION OF 2,3,7,8 SUBSTITUTED POLYCHLORINATED
DIBENZO-P-DIOXINS AND 2,3,7,8 SUBSTITUTED POLYCHLORINATED
DIBENZOFURANS IN ENVIRONMENTAL SAMPLES BY
HIGH RESOLUTION GAS CHROMATOGRAPHY-
HIGH RESOLUTION MASS SPECTROMETRY

INTRODUCTION

The purpose of this document is to describe the procedures used for determining the levels of 2,3,7,8 substituted polychlorinated dibenzo-p-dioxins and 2,3,7,8 substituted polychlorinated dibenzofurans (2,3,7,8-PCDD/PCDF) in water, ash, laboratory extracts, and soil samples. The procedure used for determination of the total levels of polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran (PCDD/PCDF) congener classes is also described.

SAMPLE HANDLING

Upon receipt, the samples are kept continuously in either locked storage or under supervision of a sample custodian. When notified of sample receipt, the designated sample custodian picks up and logs in the samples, assigning each a unique number. After the samples are logged in, they are transferred to the extraction lab following chain of custody and are assigned a new designated custodian. When the extractions are completed, the remaining samples are transferred in the original containers back to the original sample custodian for permanent storage. The sample extracts are transferred via chain of custody to the mass spectrometry laboratory for analysis by the MS sample custodian who, upon completion of the group of analyses, transfers the extracts back to the original sample custodian for storage.

EXTRACTION PROCEDURE

Aqueous Samples. Samples containing sediment are filtered and the sediment saved for extraction. Aliquots of the sample are spiked with the 5 to 40 ng of the $^{13}C_{12}$ internal standards listed in Table 1.

The samples are extracted three times with methylene chloride, the extracts combined, and then concentrated to 5 mL in a Kudurna-Danish apparatus. The dried sediments are added to thimbles containing 0.5 inches of silica gel and then extracted with benzene in a soxhlet extractor for 18 hours. The extracts are concentrated to approximately 10 mL with three-stage Snyder columns, and then added to the corresponding water extracts. The combined extracts are then further concentrated to approximately 4 mL.

Ash and Soil Samples. Ten gram aliquots of sample are spiked with the same levels of the tetra- through octa-$^{13}C_{12}$ dioxins and furans used for the aqueous samples. The Soxhlet extractor is assembled and the sample extracted for 18 hours with 250 mL of benzene. After extraction, the benzene extract is concentrated to approximately 5 mL with a 3-stage Snyder column. Method blank and native spike samples are extracted at the same time as the test samples.

The sample extract is diluted to 50 to 60 mL with hexane and washed with 1 to 5 10 mL aliquots of concentrated sulfuric acid. The combined acid washes from each extract are extracted with hexane, which is combined with the corresponding sample extract. The combined extract is concentrated to 5 mL and transferred to a multilayered silica gel column. The first layer contains 44 percent sulfuric acid on silica gel while the second contains activated silica gel, 44 percent concentrated sulfuric acid on silica gel, and 33 percent 1M sodium hydroxide on silica gel. The purpose of these columns is to remove acidic and basic compounds and easily oxidized materials from the extracts. The silica gel support provides a large surface area for contact with the sample extracts, thus improving the cleanup efficiency. The PCDD/PCDF isomers are eluted from the columns with 70 mL of hexane and the entire eluate, including the original extract volume, is collected. The hexane eluate is then concentrated to 2-3 mL with a gentle stream of nitrogen.

The hexane solution is fractionated on a column containing approximately 5 g of activated basic alumina with 10 mL of hexane/methylene chloride (97:3, v/v) and 40 mL of hexane/methylene chloride (1:1, v/v) as elution solvents. The eluate is collected, concentrated to near dryness, and diluted to 2 mL with hexane.

This eluate is then fractionated further on a column containing approximately 2 g of activated basic alumina with 3 mL of hexane/methylene chloride (97:3, v/v) and 50 mL of hexane/methylene chloride (1:1, v/v) as elution solvents. The eluate is collected, concentrated to near dryness, and dissolved in 50 µL of n-decane containing 5 to 10 ng of an absolute recovery standard, 1,2,3,4-TCDD-$^{13}C_{12}$. This solution is stored at 0 C and protected from light until analysis.

If the sample is still not suitable for analysis, additional cleanup may be used. As part of this procedure, the extract is fractionated on a column containing 1 g of activated florisil with 15 mL of hexane, 20 mL of ethyl ether/hexane (6:94, v/v), and 75 mL of methylene chloride/hexane (3:1, v/v) as elution solvents. The eluate is then taken to near dryness and brought up in 50 µL of n-decane before analysis.

ANALYSIS

The extracts are quantified for 2,3,7,8-PCDD/PCDF and/or total PCDDs/PCDFs by combined capillary column gas chromatography/high resolution mass spectrometry (HRGC/HRMS). THe HRGC/HRMS system consists of a Carlo Erba Model 4160 gas chromatograph interfaced directly into the source of a VG 7070 mass spectrometer. A 60 meter DB-5 capillary column is used to accomplish the chromatographic separations. Helium is used as a carrier gas in both types of analyses with a flow velocity of approximately 30 cm/sec. The mass spectrometer is operated in the electron impact (EI) ionization mode at a mass resolution of 9,000-12,000 (M/ΔM, 10 percent valley definition). The operating parameters of the HRGC/HRMS system are summarized in Table 2. All HRGC/HRMS data are acquired by multiple-ion-detection (MID) with a VG Model 11-250J Data System. The exact masses monitored are shown in Table 3.

QUALITY ASSURANCE

The operation of the HRGC/HRMS is evaluated each day for accuracy of quantification and isomer resolution by analyzing a standard mixture containing PCDD and/or PCDF isomers. When the analysis is for determination of 2,3,7,8-PCDD/PCDF, the mixture contains isomers listed in Table 1 along with the unlabelled isomers listed in Table 1A. The retention times for each of the 2,3,7,8 isomers, relative to the corresponding isotopically labeled congener, are also determined from this standard mixture of isomers.

Other native PCDD/PCDF isomers may also be included in this mixture but not quantified. Mixtures of selected PCDD/PCDF isomers are also analyzed once or twice a week to evaluate the stability of the chromatographic elution windows. The stability of the mass focus is assured by use of a PFK "lock mass" to correct for any mass focus drift.

Native spike and laboratory blank samples are processed during the extraction and cleanup of the samples. The native spike samples are used to evaluate the accuracy of quantification, while the method blank samples are used to demonstrate freedom from contamination.

RECOVERIES OF INTERNAL STANDARDS

The relative response factors used in determination of the recoveries of the isotopically labelled internal standards which are spiked into the samples (Table 1) are calculated by comparison of the responses from the internal standards to the response from the external standard, 1,2,3,4-TCDD-$^{13}C_{12}$, which is added following the sample extraction. The formula for this response factor calculation is:

$$Rf = \frac{Ais \times Q1234}{A1234 \times Qis}$$

where:

Rf = Response factor

Ais = Sum of integrated areas for isotopically labelled internal standards

Q1234 = Quantity of 1,2,3,4-TCDD-$^{13}C_{12}$

A1234 = Sum of integrated areas for 1,2,3,4-TCDD-$^{13}C_{12}$

Qis = Quantity of isotopically labelled internal standard.

The values for the response factors are calculated for each daily standard analysis. The average value is used in determining the recovery of the isotopically labelled internal standards. The recoveries are calculated by comparing the sum of the responses from the two ions monitored for each isotopically labelled internal standard to the sum of the responses from the two ions for the 1,2,3,4-TCDD-$^{13}C_{12}$ external standard. The formula used in the recovery calculation is:

$$\text{Recovery (\%)} = \frac{Ais \times Q1234 \times 100}{A1234 \times Qis \times Rfa}$$

where:

Ais = Sum of integrated areas for internal standard
Q1234 = Quantity of 1,2,3,4-TCDD-$^{13}C_{12}$
100 = Conversion factor for %
A1234 = Sum of integrated areas for 1,2,3,4-TCDD-$^{13}C_{12}$
Qis = Quantity of isotopically labelled internal standard
Rfa = Average response factor.

QUANTIFICATION

A relative response factor is calculated for each individual 2,3,7,8 isomer by comparing the sum of the responses from the two masses monitored for each class, at the appropriate retention time, to the sum of the responses from the two ions for the corresponding isotopically labelled internal standard in each daily standard analysis. The formula for the response factor calculations:

$$Rf = \frac{An \times Qis}{Ais \times Qn}$$

where:

Rf = Response factor
An = Sum of integrated areas for native isomer
Qis = Quantity of internal standard
Ais = Sum of integrated areas for internal standard
Qn = Quantity of native isomer.

The values calculated for the daily response factors are then averaged and this average is used in all calculations used to quantify the data.

The PCDD/PCDF isomers are then quantified by comparing the sum of the responses from the two ions monitored for each class, at the appropriate retention time, to the sum of the responses from the corresponding isotopically labelled congener. The octa-CDD-$^{13}C_{12}$ is used to quantify the octa-CDF. The formula for quantifying the PCDD/PCDF isomers is:

$$\text{Concentration (ppb)} = \frac{An \times Qis}{Ais \times W \times Rfa}$$

where:

Conc. = Concentration in parts-per-billion (ppb) of target isomer or congener class

An = Sum of integrated areas for the target isomer or congener class

Qis = Amount of internal standard in grams

Ais = Sum of integrated areas for the target isomer or congener class

W = Sample weight in grams

Rfa = Average response factor.

Each pair of resolved peaks in the selected-ion-current chromatogram is evaluated manually to determine if it meets the criteria for a PCDD or PCDF isomer. By examining each pair of peaks separately, quantitative accuracy is improved over what is obtained when all the peaks in a selected chromatographic window are averaged. When averaged data are used, it is possible for pairs of peaks with high and low chlorine isotope ratios to produce averaged data that meet the isotope ratio criterion. For example, two pairs of peaks having chlorine isotope ratios of 0.56 and 0.96, both outside of the acceptable range, would have an average ratio of 0.76.

The criteria that are used to identify PCDD and PCDF isomers are:

(1) Simultaneous responses at both ion masses;

(2) Chlorine isotope ratio within ± 15% of the theoretical value;

(3) Chromatographic retention times with in windows determined from analyses of standard mixtures;

(4) Signal-to-noise ratio equal to or greater than 2.5 to 1.

The 2,3,7,8-substituted PCDD/PCDF isomers and the octa-CDD include the additional criterion that they coelute within ± 2 seconds of their isotopically labelled analogs.

A most possible concentration (MPC) is calculated for samples in which isomers of a particular chlorine congener class are not detected. The formula used for calculating the MPC is:

$$\text{MPC (ppb)} = \frac{\text{Hn} \times \text{Qis} \times 2.5}{\text{His} \times \text{W} \times \text{Rf}}$$

where:

MPC = Single isomer most possible concentration (ppb);
Hn = Height of congener class isomers;
Qis = Quantity of internal standard (ng);
His = Peak height of internal standard;
W = Sample weight (g)
Rfa = Average response factor; and
2.5 = Signal-to-noise ratio.

ACCURACY AND PRECISION

The recovery of the ^{13}C labelled internal standards which experience the entire sample preparation is measured by comparison to the response of 1,2,3,4-TCDD-$^{13}C_{12}$ which is added to the extract immediately prior to analysis. Recoveries range between 70 and 120 percent, depending on the sample matrix. Those samples which require additional clean-up are spiked with 2,3,7,8-TCDD-$^{37}Cl_4$ as another reference for recovery calculations.

Duplicate analyses are performed periodically as another means of insuring method performance. Daily standard analysis provides a check of instrument performance and precision. Response factor calculations are compared with established values and are not to exceed 20 percent difference. Three and five point calibration curves are periodically performed to demonstrate instrument linearity.

TABLE 1. LABELLED ISOMERS FOR SAMPLE QUANTIFICATION

Isomer	Approximate Spiking Level (ng)
2,3,7,8-tetra-CDF-$^{13}C_{12}$	10
2,3,7,8-tetra-CDD-$^{13}C_{12}$	10
1,2,3,7,8-penta-CDF-$^{13}C_{12}$	10
1,2,3,7,8-penta-CDD-$^{13}C_{12}$	10
1,2,3,4,7,8-hexa-CDF-$^{13}C_{12}$	35
1,2,3,6,7,8-hexa-CDD-$^{13}C_{12}$	10
1,2,3,4,6,7,8-hepta-CDD-$^{13}C_{12}$	25
1,2,3,4,6,7,8-hepta-CDF-$^{13}C_{12}$	25
Octa-CDD-$^{13}C_{12}$	25

TABLE 1A. NATIVE ISOMERS FOR RESPONSE FACTORS AND RETENTION TIMES

Isomer	Approximate Spiking Level (ng)
2,3,7,8-tetra-CDF	10
2,3,7,8-tetra-CDD	10
1,2,3,7,8-penta-CDF	10
2,3,4,7,8-penta-CDF	10
1,2,3,7,8-penta-CDD	10
1,2,3,4,7,8-hexa-CDF	10
1,2,3,6,7,8-hexa-CDF	10
1,2,3,7,8,9-hexa-CDF	10
2,3,4,6,7,8-hexa-CDF	10
1,2,3,6,7,8-hexa-CDD	10
1,2,3,4,7,8-hexa-CDD	10
1,2,3,7,8,9-hexa-CDD	10
1,2,3,4,6,7,8-hepta-CDF	25
1,2,3,4,7,8,9-hepta-CDF	25
1,2,3,4,6,7,8-hepta-CDD	25
Octa-CDD	25
Octa-CDF	25

TABLE 2. HRGC/HRMS OPERATING PARAMETERS

Mass Resolution	9000-12000 ($M/\Delta M$, 10% valley definition)
Electron Energy	70 eV
Accelerating Voltage	4000 volts (7070H) or 6000 volts (7070E)
Source Temperature	225-250 C
Preamplifier Gain	10^{-7} amp/volt
Electron Multiplier Gain	$\sim 10^{6}$
Column	CP Sil 88 50M or DB-5 60M
Transfer Line Temperature, DB-5	300 C
Injector Temperature, DB-5	300 C
Column Temperature-Initial, DB-5	160 C
Column Temperature-Program, DB-5	20 C/min to 240 C hold for 40 min 20 C/min to 320 C hold for 30 min
Carrier Gas	Helium
Flow Velocity	~30 cm/min
Injection Mode	Splitless
Injection Volume	0.5-2 µL

TABLE 3. EXACT MASSES USED FOR THE DETERMINATION OF PCDD AND PCDF

Compound	Accurate Mass Mass 1	 Mass 2	Theoretical Isotope Ratio Mass 1/Mass 2
Tetrachlorodibenzo-p-dioxins	319.8965	321.8936	0.77
Tetrachlorodibenzofurans	303.9016	305.8987	0.77
Pentachlorodibenzo-p-dioxins	355.8546	357.8517	1.54
Pentachlorodibenzofurans	339.8597	341.8567	1.54
Hexachlorodibenzo-p-dioxins	389.8156	391.8127	1.23
Hexachlorodibenzofurans	373.8207	375.8178	1.23
Heptachlorodibenzo-p-dioxins	423.7766	425.7737	1.03
Heptachlorodibenzofurans	407.7817	409.7788	1.03
Octachlorodibenzo-p-dioxins	457.7377	459.7347	0.88
Octachlorodibenzofurans	441.7428	443.7398	0.88
Tetrachlorodibenzo-p-dioxin-$^{13}C_{12}$	331.9367	333.9338	0.77
Tetrachlorodibenzofuran-$^{13}C_{12}$	315.9418	317.9389	0.77
Pentachlorodibenzo-p-dioxin-$^{13}C_{12}$	367.8948	369.8918	1.54
Pentachlorodibenzofuran-$^{13}C_{12}$	351.8999	353.8969	1.54
Hexachlorodibenzo-p-dioxin-$^{13}C_{12}$	401.8558	403.8529	1.23
Hexachlorodibenzofuran-$^{13}C_{12}$	385.8609	387.8580	1.23
Heptachlorodibenzo-p-dioxin-$^{13}C_{12}$	435.8168	437.8139	1.03
Heptachlorodibenzofuran-$^{13}C_{12}$	419.8219	421.8190	1.03
Octachlorodibenzo-p-dioxin-$^{13}C_{12}$	469.7779	471.7749	0.88

APPENDIX B

APPENDIX B

Modified Method 680 for Special Analytical Services Test

Identification and Measurement of Pesticides and PCBs by Gas Chromatography/Mass Spectrometry

November 18, 1985

For further information, contact Ann Alford-Stevens or James W. Eichelberger, Physical and Chemical Methods Branch, Environmental Monitoring and Support Laboratory, Office of Research and Development, U. S. Environmental Protection Agency, Cincinnati, Ohio 45268.

1. SCOPE AND APPLICATION

1.1. This method provides procedures for identification and measurement of polychlorinated biphenyls (PCBs) and the pesticides listed below. This method is applicable to samples containing PCBs as single congeners or as complex mixtures, such as commercial Aroclors. PCBs are identified and measured as isomer groups (i.e., by level of chlorination). The existence of 209 possible PCB congeners makes impractical the listing of the Chemical Abstracts Service Registry Number (CASRN) for each potential method analyte. Because PCBs are identified and measured as isomer groups, the non-specific CASRN for each level of chlorination is used to describe method analytes.

Analyte(s)	Formula	CASRN
Aldrin	$C_{12}H_8Cl_6$	309-00-2
BHC, alpha	$C_6H_6Cl_6$	319-84-6
BHC, beta	$C_6H_6Cl_6$	319-85-7
BHC, delta	$C_6H_6Cl_6$	319-86-8
BHC, gamma	$C_6H_6Cl_6$	58-89-9
Chlordane, alpha	$C_{10}H_6Cl_8$	5103-71-9
Chlordane, gamma	$C_{10}H_6Cl_8$	5103-74-2
4,4'-DDD	$C_{14}H_{10}Cl_4$	72-54-8
4,4'-DDE	$C_{14}H_8Cl_4$	72-55-9
4,4'-DDT	$C_{14}H_9Cl_5$	50-29-3
Dieldrin	$C_{12}H_8Cl_6O$	60-57-1
Endosulfan I	$C_9H_6Cl_6O_3S$	959-98-8
Endosulfan II	$C_8H_6Cl_6O_3S$	33213-65-9
Endosulfan sulfate	$C_9H_4Cl_6O_4S$	1031-07-8
Endrin	$C_{12}H_8Cl_6O$	72-20-8
Endrin ketone	$C_{12}H_8Cl_6O$	53494-70-5
Heptachlor	$C_{10}H_5Cl_7$	76-44-8
Heptachlor epoxide	$C_{10}H_5Cl_7O$	1024-57-3
Methoxychlor	$C_{16}H_{15}Cl_3O_2$	72-43-5
Nonachlor, trans	$C_{10}H_5Cl_9$	39765-80-5
PCBs		
Monochlorobiphenyls	$C_{12}H_9Cl$	27323-18-8
Dichlorobiphenyls	$C_{12}H_8Cl_2$	25512-42-9
Trichlorobiphenyls	$C_{12}H_7Cl_3$	25323-68-6
Tetrachlorobiphenyls	$C_{12}H_6Cl_4$	26914-33-0
Pentachlorobiphenyls	$C_{12}H_5Cl_5$	25429-29-2
Hexachlorobiphenyls	$C_{12}H_4Cl_6$	26601-64-9
Heptachlorobiphenyls	$C_{12}H_3Cl_7$	28655-71-2
Octachlorobiphenyls	$C_{12}H_2Cl_8$	31472-83-0
Nonachlorobiphenyls	$C_{12}HCl_9$	53742-07-7
Decachlorobiphenyl	$C_{12}Cl_{10}$	2051-24-3

1.2 Detection limits vary among method analytes and with sample matrix, sample preparation procedures, and individual samples, depending on the type and quantity of other sample components. The following guidance is based on numerous analyses of calibration solutions with one instrument over a period of approximately six months. Pesticide analytes other than endosulfans I and II can be identified and accurately measured when the injected aliquot contains 2 ng of each analyte; the endosulfans require about 4 ng each. Detection limits for individual PCB congeners increase with increasing number of chlorine atoms, with the detection limit for decachlorobiphenyl being about 5-10 times higher than that of a monochlorobiphenyl. A monochlorobiphenyl can be identified and measured when the injected extract aliquot contains 1 ng. The detection limit for total PCBs will depend on the number of individual PCB congeners present.

2. SUMMARY OF METHOD

Sample extract components are separated with capillary column gas chromatography (GC) and identified and measured with low resolution, electron ionization mass spectrometry (MS). An interfaced data system (DS) to control data acquisition and to store, retrieve, and manipulate mass spectral data is essential. Two surrogate compounds are added to most samples before sample preparation; these compounds are $^{13}C_{12}$-4,4'-DDT and $^{13}C_6$-gamma-BHC. Two internal standards, chrysene-d_{12} and phenanthrene-d_{10}, are added to each sample and blank extract before GC/MS analysis and are used to calibrate MS response. Each concentration measurement is based on an integrated ion abundance of one characteristic ion.

All pesticides are identified as individual compounds, and a concentration is calculated by relating the MS response of each compound to the MS response of one of the two internal standards, usually the internal standard with GC retention time nearer that of the pesticide analyte. This has been predetermined by order of library entries with the specialized software for automated identifications and measurements.

PCBs are identified and measured as isomer groups (i.e., by level of chlorination). A concentration is measured for each PCB isomer group; total PCB concentration in each sample extract is obtained by summing isomer group concentrations. Nine selected PCB congeners are used as calibration standards, and one internal standard, chrysene-d_{12}, is used to calibrate MS response.

3. DEFINITIONS

3.1 Concentration calibration solution (CAL) -- A solution of PCB calibration congeners, pesticide analytes, surrogate compounds, and internal standards used to calibrate the mass spectrometer response.

3.2 Congener number -- Througout this method, individual PCBs are described with the number assigned by Ballschmiter and Zell (1). (This number is also used to describe PCB congeners in catalogs produced by Ultra Scientific, Hope, RI.)

3.3 Internal standard -- A pure compound added to each sample and blank extract in known amounts and used to calibrate concentration measurements of PCBs and pesticide analytes that are sample components. The internal standard must be a compound that is not a sample component.

3.4 Laboratory performance check solution (LPC) -- A solution of method analytes, surrogate compounds, and internal standards used to evaluate the performance of the GC/MS/DS with respect to a defined set of method criteria.

3.5 Laboratory reagent blank (LRB) -- An aliquot of extraction solvent that is exposed to all glassware, apparatus, equipment, method reagents, etc., that a sample extract solvent would be exposed to. All internal standards and surrogates are used with the LRB solvent, which is concentrated to the final volume of a sample extract and is analyzed exactly the same as an sample extract.

3.6 Laboratory surrogate spike - measured value (LS1) -- The surrogate compound concentration measured with the same procedures used to measure sample components.

3.7 Laboratory surrogate spike - theoretical value (LS2) -- The known or true value of the concentration of surrogate compound added to the environmental sample The known value is determined from standard gravimetric and/or volumetric techniques used during sample fortification.

3.8 Surrogate compound -- A compound that is not expected to be found in the sample, is added to the original environmental sample to monitor performance, and is measured with the same procedures used to measure sample components. Associated with the surrogate compound are two values, laboratory surrogate spike - measured value (LS1) and laboratory surrogate spike - theoretical value (LS2).

4. INTERFERENCES

4.1 Interferences may be caused by contaminants in solvents, reagents, glassware, and other sample processing equipment. All of these materials must be demonstrated to be free of interferences by routine analysis of laboratory solvent blanks (LSB).

4.2 For both pesticides and PCBs, interference can be caused by the presence of much greater quantities of other sample components that overload the capillary column; additional sample extract preparation procedures must then be used to eliminate interferences. Capillary column GC retention times and the compound-specific characteristics of mass spectra eliminate many interferences that formerly were of concern with pesticide/PCB determinations with electron capture detection. The approach and identification criteria used in this method for PCBs eliminate interference by most chlorinated compounds other than other PCBs. With the isomer group approach, coeluting PCBs that contain the same number of chlorines are identified and measured together. Therfore, coeluting PCBs are a problem only if they contain different number of chlorine atoms. This interference problem is obviated by the rigorous identification criteria incorporated into the specialized software.

5. APPARATUS AND EQUIPMENT

5.1 COMPUTERIZED GC/MS SYSTEM

5.1.1 The GC must be capable of temperature programming and be equipped with all required accessories, such as syringes, gases, and a capillary column. The GC injection port must be designed for capillary columns. Manual splitless injections were used to acquire data used as the basis for quality control requirements. An automatic injector, however, is desirable, because it should provide more precise retention times and areas. On-column injection techniques are encouraged because they minimize high mass descrimination and analyte degradation problems.

With some GCs, however, the irreproducibility of the low initial temperature required for on-column injections will cause irreproducible retention times (RTs) and relative retention times (RRTs). That can result in an inability to distinguish between two closely eluting pesticide isomers. Splitting injections are not recommended.

5.1.2 Full range mass spectra are obtained with electron ionization at a nominal electron energy of 70 eV. To ensure sufficient precision of mass spectral data, the required MS scan rate must allow acquisition of at least five full-range mass spectra while a sample component elutes from the GC. The MS must produce a mass spectrum meeting all usual criteria for $\leq$20 ng of decafluorotriphenylphosphine (DFTPP) introduced through the GC inlet.

5.1.3 An interfaced data system (DS) is required to acquire, store, reduce, and output mass spectral data. The DS must be capable of searching a data file for specific ions and plotting ion abundances versus time or spectrum number to produce extracted ion current profiles (EICPs). Also required is the capability to obtain chromatographic peak areas between specified times or spectrum numbers in EICPs. Total data acquisition time per cycle should be $\geq$0.5 s and must not exceed 1.5 s.

5.2 GC COLUMN -- A 30 m X 0.32 mm ID fused silica capillary column coated with a 0.25 um or thicker film crosslinked phenyl methyl silicone (such as Durabond-5 (DB-5), J and W Scientific, Rancho Cordova, CA) or polydiphenyl vinyl dimethyl siloxane (such as SE-54, Alltech Associates, Deerfield, IL) is required. Operating conditions known to produce acceptable results with these columns are shown in Table 1; separation of pesticide analytes and PCB calibration congeners with a DB-5 column and those operating conditions is shown in Figure 1. Retention times have been reported (2) for all 209 PCB congeners with an SE-54 column, which provides the same retention order for PCBs and essentially the same separation capabilities as a DB-5 column.

5.3 MISCELLANEOUS EQUIPMENT

5.3.1 Volumetric flasks - various common sizes with ground glass stoppers

5.3.2 Microsyringes - various common sizes

6. REAGENTS AND CONSUMABLE MATERIALS

6.1 SOLVENTS -- High purity, distilled-in-glass.

6.2 MS PERFORMANCE CHECK SOLUTION -- Prepare a 10 ng/uL solution of decafluorotriphenylphosphine (DFTPP) in an appropriate solvent.

6.3 INTERNAL STANDARDS -- Chrysene-d_{12} and phenanthrene-d_{10} are used as internal standards. They are added to each sample extract just before analysis and are contained in all concentration calibration and performance check solutions. A solution of internal standards is provided.

6.4 SURROGATE COMPOUNDS -- $^{13}C_{12}$-4,4'-DDT and $^{13}C_{6}$-gamma-BHC are added to every blank and to most samples before extraction and are included in every concentration calibration/ performance check solution. Required solutions of surrogate compounds are provided.

6.5 PCB CONCENTRATION CALIBRATION CONGENERS -- The nine individual PCB congeners listed in Table 2 are used as concentration calibration compounds for PCB determinations. One isomer at each level of chlorination is used as the concentration calibration standard for all other isomers at that level of chlorination, except that decachlorobiphenyl (Cl_{10}) is used for both Cl_9 and Cl_{10} isomer groups. The needed solution of PCB congeners is provided.

6.6 PESTICIDE CALIBRATION SOLUTION -- Provided.

6.10 CALIBRATION SOLUTIONS (CALs) -- Five hexane solutions are required. Instructions for preparation of CALS are provided with the PCB calibration congener solution. CALs contain a constant concentration of the ISs (chrysene-d_{12} and phenanthrene-d_{10}) and varying concentrations of the individual pesticide analytes, the nine PCB calibration congeners, and the two surrogate compounds ($^{13}C_{12}$-DDT and $^{13}C_6$-gamma-BHC). (Composition and concentrations are given in Table 3.) Each solution contains both ISs, both surrogate compounds, the nine PCB concentration calibration congeners, and each of the single-compound pesticide analytes. The lowest concentration solution contains each individual pesticide analytes and PCB calibration congener at a concentration near but greater than its anticipated detection limit. (Because MS response to PCBs decreases with increasing level of chlorination, PCB congener concentrations in CALS increase with level of chlorination.) Components of the highest concentration CAL are present at a concentration that allows injections of 2-uL aliquots without MS saturation or GC column overloading.

6.11 LABORATORY PERFORMANCE CHECK SOLUTION -- The medium concentration CAL (#3, Table 3) is used as the laboratory performance check solution (LPC) to verify response factors and to demonstrate adequate GC resolution and MS performance.

7. CALIBRATION

Demonstration and documentation of initial calibration are required before any samples are analyzed and intermittently throughout sample analyses as dictated by results of continuing calibration checks. After initial calibration is successfully performed, a continuing calibration check is required at the beginning and end of each 12-h period during which analyses are performed.

7.1. INITIAL CALIBRATION

7.1.1 Calibrate and tune the MS with standards and procedures prescribed by the manufacturer with any necessary modifications to meet USEPA requirements.

7.1.2 Inject a 2-uL aliquot of the 10 ng/uL DFTPP solution and acquire a mass spectrum that includes data for m/z 45-450. If the spectrum does not meet all usual criteria, the MS must be hardware tuned to meet all criteria before proceeding with calibration.

7.1.3 Inject a 2-uL aliquot of the medium concentration CAL and acquire data from m/z 45 to 510. Acquire ≥5 spectra during elution of each GC peak. Total cycle time should be ≥0.5 s and ≤1.5 s.

7.1.4 Performance Criteria

7.1.4.1 GC performance -- baseline separation of beta-BHC and gamma-BHC; baseline separation of endrin ketone and chrysene-d_{12}; height of Cl_1-PCB peak $\geq$80% beta-BHC peak height; height of chrysene-d_{12} peak $\geq$20% of the peak height of methoxychlor coeluting with the Cl_8-PCB congener. (If methoxychlor and Cl_8-PCB are resolved, chrysene-d_{12} peak height = $\geq$40% of each.)

7.1.4.2 MS sensitivity -- Signal/noise ratio of $\geq$5 for m/z 499 of PCB congener #209, Cl_{10}-PCB.

7.1.4.3 MS calibration -- Abundance of $\geq$40% and $\leq$60% of m/z 502 relative to m/z 498 for PCB congener #209.

7.1.4.4 Lack of degradation of endrin. Examine an extracted ion current profile (EICP) for m/z 67 in the retention time window between 4,4-DDE and endosulfan sulfate; confirm that the abundance of m/z 67 at the retention time of endrin aldehyde (See Figure 1) is <10% of the abundance of m/z 67 produced by endrin.

7.1.4.5 Lack of degradation of $^{13}C_{12}$-4,4'-DDT. Examine EICPs for m/z 258 and m/z 247 in the retention time window that includes 4,4'-DDD, 4,4'-DDE and 4,4'-DDT; m/z 258 would be produced by $^{13}C_{12}$-4,4'DDE, and m/z 247 by $^{13}C_{12}$-4,4'-DDD. Confirm that the total abundance of both ions is <5% of m/z 247 produced by $^{13}C_{12}$-4,4'-DDT.

7.1.5 Replicate Analyses of CALs -- If all performance criteria are met, analyze each of the other four CALs.

7.1.6 Response Factor Calculation

7.1.6.1 Calculate five response factors (RFs) for each pesticide analyte, PCB calibration congener, and surrogate compound relative to either phenanthrene-d_{10} or chrysene-d_{12}. (Phenanthrene-d_{10} is used for pesticides eluting before heptachlor epoxide; Chrysene-d_{12} is used for all PCBs and for heptachlor epoxide and later eluting pesticides.) Use standard Incos procedures to calculate each RF:

$$RF = A_x Q_{is} / A_{is} Q_x$$

where A_x = integrated ion abundance of quantitation ion for a pesticide, a PCB calibration congener or a surrogate compound,

A_{is} = integrated ion abundance of m/z 240, the quantitation ion when chrysene-d_{12} is used as the internal standard or m/z 188, the quantitation ion when phenanthrene-d_{10} is used as the internal standard,

Q_{is} = injected quantity of chrysene-d_{12} or phenanthrene-d_{10},

Q_x = injected quantity of pesticide analyte, PCB calibration congener or surrogate compound.

RF is a unitless number, units used to express quantities must be equivalent.

7.1.7 Response Factor Reproducibility -- For each pesticide analyte, PCB calibration congener and surrogate compound, calculate the mean RF from analyses of each of the five CALS. When the RSD exceeds 20%, analyze additional aliquots of appropriate CALS to obtain an acceptable RSD of RFs over the entire concentration range, or take action to improve GC/MS performance.

7.1.8 Record a spectrum of each CAL component. (Background subtraction and spectrum averaging may be needed.) Judge the acceptability of recorded spectra by comparing them to spectra in libraries and by using information in Tables 4-6. If an acceptable spectrum of a pesticide analyte or PCB calibration congener is not acquired, take necessary actions to correct GC/MS performance. If performance cannot be corrected, report sample extract data for the particular compound(s), but document the affected compound(s) and the nature of the problem.

7.2. CONTINUING CALIBRATION CHECK

7.2.1 With the following procedures, verify initial calibration at the beginning and end of each 12-h period during which analyses are to be performed.

7.2.2 Calibrate and tune the MS with standards and procedures prescribed by the manufacturer.

7.2.3 Analyze a 2-uL aliquot of the DFTPP solution and ensure acceptable MS calibration and performance.

7.2.4 Inject a 2-uL aliquot of CAL #3 (Table 3) and analyze with the same conditions used during Initial Calibration.

7.2.5 Demonstrate acceptable performance for criteria described in Sect. 7.1.4.

7.2.6 Determine that neither the area measured for m/z 240 for chrysene-d_{12} nor that for m/z 188 for phenanthrene-d_{10} has decreased by more than 25% from the area measured in the most recent previous analysis of a calibration solution and by more than 50% from the mean area measured during initial calibration.

7.2.7 RF Reproducibility - For an acceptable Continuing Calibration Check, the measured RF for each analyte/surrogate compound must be within ±20% of the mean value calculated (Sect. 7.1.6) during Initial Calibration. If not, remedial action must be taken; recalibration may be necessary.

7.2.8 Remedial actions must be taken if criteria are not met; possible remedies are:

- 7.2.8.1 Check and adjust GC and/or MS operating conditions.
- 7.2.8.2 Clean or replace injector liner.
- 7.2.8.3 Flush column with solvent according to manufacturers instructions.
- 7.2.8.4 Break off a short portion (approximately 0.33 m) of the column; check column performance by analysis of performance check solution.
- 7.2.8.5 Replace GC column; performance of all initial calibration procedures then required.
- 7.2.8.6 Adjust MS for greater or lesser resolution.
- 7.2.8.7 Calibrate MS mass scale.
- 7.2.8.8 Perform initial calibration procedures.

8. PROCEDURES

8.1 GC/MS ANALYSIS

8.1.1 Remove the sample extract or blank from storage and allow it to warm to ambient laboratory temperature if necessary. With a stream of dry, filtered nitrogen, reduce the extract/blank volume to the appropriate volume. Final volume for all blanks and all samples except ORD-11 is 1 mL; final volume for ORD-11 is 10 mL. (See attached flow chart for extract preparation scheme for solid samples.) If sample ORD-11, add 200 uL of the IS solution; otherwise, add 20 uL of the IS solution. Internal standard concentration = 7.5 ng/uL of extract.

8.1.2 Inject a 2-uL aliquot of the extract/blank into the GC operated under conditions used to produce acceptable results during calibration.

8.1.3 Acquire mass spectral data with the same data acquisition time and GC/MS operating conditions previously used to determine response factors.

8.1.4 Examine data for saturated ions in mass spectra of target compounds, if saturation occurred, dilute and reanalyse the extract after the quantity of the ISs is adjusted appropriately.

8.1.5 For each IS, determine that the area measured in the sample extract has not decreased by >25% from the area measured during the most recent previous analysis of a calibration solution or by >50% from the mean area measured during initial calibration. If either criterion is not met, remedial action must be taken to improve sensitivity, and the sample extract must be reanalysed.

8.2 IDENTIFICATION AND MEASUREMENT PROCEDURES -- Use software for automated identification and measurement of PCBs and pesticides. (See Users' Guide)

8.2.1 Use the grand mean RF calculated during Initial Calibration. CAUTION: For PCB analyses with automated data interpretation a linear fit algorithm will produce erroneous concentration data.

8.2.2 Examine results obtained on the status report (for individual components identified as PCBs) and the quantitation report (for pesticide analytes) and PCB isomer groups. Individual spectra should be examined and compared to appropriate spectra acquired during calibration.

8.2.2 Report calculated values to three significant figures.

REFERENCES

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2. Mullin, M. D., C. Pochini, S. McCrindle, M. Romkes, S. H. Safe, and L. M. Safe, "High Resolution PCB Analysis: Synthesis and Chromatographic Properties of All 209 PCB Congeners", Environ. Sci. Technol. 18, 466, 1984.

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Table 1. Recommended GC Operating Conditions

Column Type:	SE-54 or DB-5
Film Thickness:	≥0.25 um
Column Dimensions:	30 m X 0.32 mm
Helium Linear Velocity:	28-29 cm/sec at 250°C
Temperature Program for Splitless Injection: (Analysis time = approximately 40 min)	Inject at 80°C and hold 1 min; increase at 30°/min to 160°C and hold 1 min; increase at 3°/min to 310°C. or Inject at 80°C and hold 1 min; heat rapidly to 160°C and hold 1 min; increase at 3°/min to 310°C.

Table 2. PCB Congeners Used as Concentration Calibration Standards

Isomer Group	Congener Number	Chlorine Substitution	Approx. RRT[a]
Monochlorobiphenyl	1	2	0.30
Dichlorobiphenyl	5	2,3	0.43
Trichlorobiphenyl	29	2,4,5	0.54
Tetrachlorobiphenyl	50	2,2',4,6	0.56
Pentachlorobiphenyl	87	2,2',3,4,5'	0.80
Hexachlorobiphenyl	154	2,2',4,4',5,6'	0.82
Heptachlorobiphenyl	188	2,2',3,4',5,6,6'	0.88
Octachlorobiphenyl	200	2,2',3,3',4,5',6,6'	1.03
Nonachlorobiphenyl[a]	-	---	-
Decachlorobiphenyl	209	2,2',3,3',4,4',5,5',6,6'	1.3

[a] Retention time relative to chrysene-d_{12} with a 30 m X 0.31 mm ID SE-54 fused silica capillary column and the following GC conditions: splitless injection at 80°C; hold for 1 min; heat rapidly to 160°C and hold 1 min; increase at 3°C/min to 310°C.

[b] Decachlorobiphenyl is used as the calibration congener for both nona- and decachlorobiphenyl isomer groups.

Table 4. Known Relative Abundances of Ions in PCB Molecular Ion Clusters

m/z	Relative Intensity
Monochlorobiphenyls	
188	100
189	13.5
190	33.4
192	4.41
Dichlorobiphenyls	
222	100
223	13.5
224	66.0
225	8.82
226	11.2
227	1.44
Trichlorobiphenyls	
256	100
257	13.5
258	98.6
259	13.2
260	32.7
261	4.31
262	3.73
263	0.47
Tetrachlorobiphenyls	
290	76.2
291	10.3
292	100
293	13.4
294	49.4
295	6.57
296	11.0
297	1.43
298	0.95
Pentachlorobiphenyls	
324	61.0
325	8.26
326	100
327	13.5
328	65.7
329	8.78
330	21.7
331	2.86
332	3.62
333	0.47
334	0.25
Hexachlorobiphenyls	
358	50.9
359	6.89
360	100
361	13.5
362	82.0
363	11.0
364	36.0
365	4.77
366	8.92
367	1.17
368	1.20
369	0.15
Heptachlorobiphenyls	
392	43.7
393	5.91
394	100
395	13.5
396	98.3
397	13.2
398	53.8
399	7.16
400	17.7
401	2.34
402	3.52
403	0.46
404	0.40
Octachlorobiphenyls	
426	33.4
427	4.51
428	87.3
429	11.8
430	100
431	13.4
432	65.6
433	8.76
434	26.9
435	3.57
436	7.10
437	0.93
438	1.18
439	0.15
440	0.11
Nonachlorobiphenyls	
460	26.0
461	3.51
462	76.4
463	10.3
464	100
465	13.4
466	76.4
467	10.2
468	37.6
469	5.00
470	12.4
471	1.63
472	2.72
473	0.35
474	0.39
Decachlorobiphenyl	
494	20.8
495	2.81
496	68.0
497	9.17
498	100
499	13.4
500	87.3
501	11.7
502	50.0
503	6.67
504	19.7
505	2.61
506	5.40
507	0.71
508	1.02
509	0.13

Source: J. W. Rote and W. J. Morris, *J. Assoc. Offic. Anal. Chem.* *56*, 188, 1973.

Table 5. Quantitation, Confirmation, and Interference Check Ions for PCBs, Internal Standards, and Surrogate Compounds

Analyte/ IS/Surr.	Approx. RRT Range	Nom. MW	Quant. Ion	Confirm. Ion	Expected Ratio[a]	Accept. Ratio[a]	M-70 Confirm. Ion	Interference Check Ions M+70	Interference Check Ions M+35
PCB Isomer Group									
Cl_1	0.30-0.35	188	188	190	3.0	2.5-3.5	152[b]	256	222
Cl_2	0.38-0.50	222	222	224	1.5	1.3-1.7	152	292	256
Cl_3	0.46-0.64	256	256	258	1.0	0.8-1.2	186	326	290
Cl_4	0.55-0.82	290	292	290	1.3	1.1-1.5	220	360	326
Cl_5	0.64-0.92	324	326	324	1.6	1.4-1.8	254	394	360
Cl_6	0.75-1.1	358	360	362	1.2	1.0-1.4	288	430	394
Cl_7	0.88-1.2	392	394	396	1.0	0.8-1.2	322	464	430
Cl_8	0.99-1.21	426	430	428	1.1	0.9-1.3	356	498	464
Cl_9	1.16-1.28	460	464	466	1.3	1.1-1.5	390	-	498
Cl_{10}	1.3	494	498	500	1.1	0.9-1.3	424	-	-
Internal standard									
Chrysene-d_{12}		240	240	241	5.1	4.3-5.9	-	-	-
Phenanthrene-d_{10}		188	188	189	6.6	6.0-7.2	-	-	-
Surrogate compound									
$^{13}C_6$-gamma-BHC		294	187	189		1.1-1.4	-	-	-
$^{13}C_{12}$-4,4'-DDT		364	247	249	1.5	1.2-1.8	-	-	-

[a] Ratio of quantitation ion to confirmation ion

[b] Monodichlorobiphenyls lose HCl to produce an ion at m/z 152.

Table 6. Quantitation and Characteristic Ions for Pesticide Analytes, Internal Standards and Surrogate Compounds (Ordered by Retention Time)

Analyte/Internal Std/ Surrogate Compound	(MW)	Approx. RRT	Quant. Ion	Ions (Approximate Relative Abundance)
Alpha-BHC	(362)	0.43	219	181 (100), 183 (90), 219 (70)
Beta-BHC	(288)	0.47	219	181 (100), 183 (90), 219 (70)
Gamma-BHC	(288)	0.48	219	181 (100), 183 (90), 219 (75)
$^{13}C_6$-gamma-BHC	(294)	0.48	225	187 (100), 189 (90) 225 (80), 227 (40)
Phenanthrene-d_{10}	(188)	0.49	188	188 (100), 189 (15),
Delta-BHC	(288)	0.51	219	181 (100), 183 (90), 219 (70)
Heptachlor	(370)	0.58	272	100 (100), 272 (60), 274 (40)
Aldrin	(362)	0.64	263	66 (100), 263 (40), 265 (25)
Heptachlor epoxide	(386)	0.70	353	81 (100), 353 (80), 355 (65)
Gamma-chlordane	(406)	0.74	373	373 (100), 375 (95)
Endosulfan I	(404)	0.76	195	195 (100), 339 (50), 341 (35)
Alpha-chlordane	(406)	0.76	373	373 (100), 375 (95)
Trans-nonachlor	(440)	0.77	409	409 (100), 407 (85)
Dieldrin	(378)	0.80	79	79 (100), 263 (10), 108 (15)
4,4'-DDE	(316)	0.81	246	246 (100), 248 (65)
Endrin	(378)	0.83	81	81 (100), 263 (75)
Endosulfan II	(404)	0.85	195	195 (100), 339 (50), 341 (35)
4,4'-DDD	(318)	0.87	235	235 (100), 237 (65), 165 (65)
Endrin aldehyde	(378)	0.88	67	67 (100), 345 (30)
Endosulfan sulfate	(420)	0.92	272	272 (100), 274 (80), 387 (50)
4,4'-DDT	(352)	0.93	235	235 (100), 237 (65), 165 (65)
$^{13}C_{12}$-4,4'-DDT	(364)	0.93	247	247 (100), 249 (65)
Endrin ketone	(378)	0.99	67	67 (100), 317 (50)
Chrysene-d_{12}	(240)	1.00	240	240 (100), 241 (20)
Methoxychlor	(344)	1.03	227	227 (100), 228 (15)

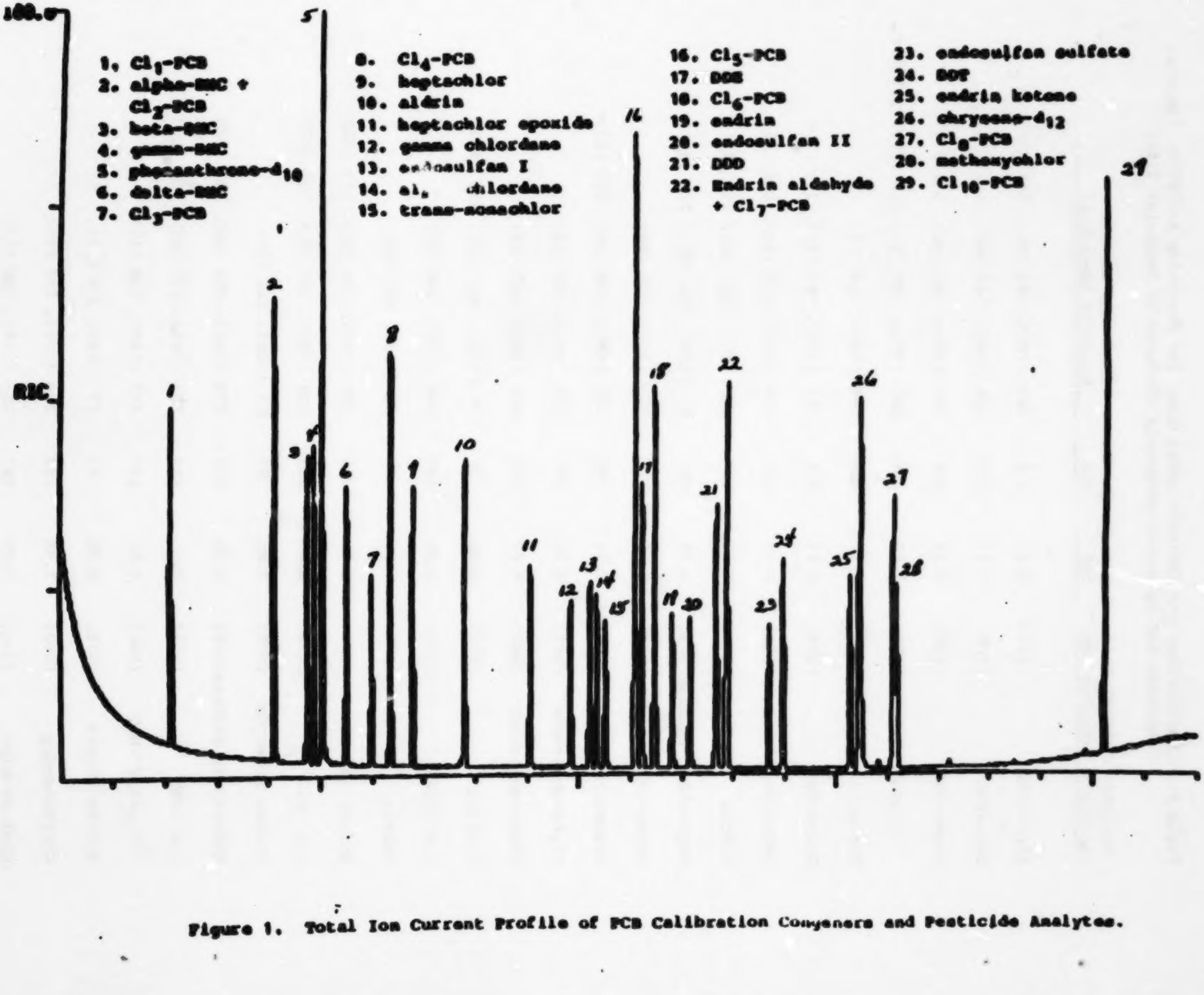

Figure 1. Total Ion Current Profile of PCB Calibration Congeners and Pesticide Analytes.

B

APPENDIX B

ASH RESULTS

(ZA) ASH

SAMPLE NUMBER:			ZA AH 001	ZA AH 002	ZA-AH-003	ZA-AH-003D	ZA-AH-004	ZA-AH-005
DILUTION FACTOR:					1	20		
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH	ASH
UNITS:			UG/KG		UG/KG	UG/KG		
*** BASE/NEUTRALS ***								
PP	CAS NO	COMPOUND						
66B	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA		250000	NA	NA
69B	117-84-0	DI-N-OCTYL PHTHALATE	NA	NA	2000T		NA	NA
68B	84-74-2	DI-N-BUTYL PHTHALATE	NA	NA	430JB		NA	NA

(ZA) ASH

SAMPLE NUMBER:	ZA AH 001	ZA AH-002	ZA AH 003	ZA AH 003D	ZA AH-004	ZA-AH-005
DILUTION FACTOR:						
DESCRIPTION:	ASH	ASH	ASH	ASH	ASH	ASH
UNITS:	UG/KG		UG/KG	UG/KG		

*** ACIDS ***

PP	CAS NO	COMPOUND

NO PARAMETERS DETECTED FOR THIS CATEGORY

(ZA) ASH

SAMPLE NUMBER:	ZA-AH-001	ZA-AH-002	ZA-AH-003	ZA-AH-003D	ZA-AH-004	ZA-AH-005
DILUTION FACTOR:						
DESCRIPTION:	ASH	ASH	ASH	ASH	ASH	ASH
UNITS:	UG/KG		UG/KG	UG/KG		
*** PESTICIDES ***						
PP / CAS NO / COMPOUND						
DICHLOROBIPHENYL	NA	NA	107	NA	NA	NA

(ZA) ASH

SAMPLE NUMBER:	ZA-AH-001	ZA-AH-002	ZA-AH-003	ZA-AH-003D	ZA-AH-004	ZA-AH-005
DILUTION FACTOR:						
DESCRIPTION:	ASH	ASH	ASH	ASH	ASH	ASH
UNITS:						
2378 TCDD			10			
TOTAL TCDD			216			
2378 TCDF			263			
TOTAL TCDF			1251			
12378 PeCDD			33			
TOTAL PeCDD			350			
12378 PeCDF			61			
23478 PeCDF			46			
TOTAL PeCDF			591			
123478 HxCDD			12			
123678 HxCDD			17			
123789 HxCDD			28			
TOTAL HxCDD			211			
123478 HxCDF			74			
123678 HxCDF			131			
123789 HxCDF			36			
234678 HxCDF			5			
TOTAL HxCDF			527			
1234678 HpCDD			159			
TOTAL HpCDD			299			
1234678 HpCDF			139			
1234789 HpCDF			8			
TOTAL HpCDF			198			
OCDD			313			
OCDF			66			

Dioxin Results are in pg/g

Note: Only 1 Ash Sample From This Facility Was Analyzed For Dioxins.

(ZA) ASH

SAMPLE NUMBER:			ZA-AH-001	ZA-AH-002	ZA-AH-003	ZA-AH-003D	ZA-AH-004	ZA-AH-005
DILUTION FACTOR:								
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH	ASH
UNITS:			MG/KG	MG/KG	MG/KG		MG/KG	MG/KG
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC	50	49	51		45	37
4		BARIUM	529	400	554		523	436
6		CADMIUM	43	41	56		32	41
8		CHROMIUM	93	90	79		64	55
10		COPPER	1420	7360	1160		994	946
11		IRON	63300	57400	48600		44100	46000
12		LEAD	1580	1180	1820		1480	1660
14		MANGANESE	1020	835	849		1360	587
15		MERCURY	10.4	22.9	25.1		16.9	18.0
19		SILVER	4.8	5.0	8.7		4.1	7.9
20		SODIUM	10200	9970	11000		9350	10400
24		ZINC	6900	4310	6600		4740	4540

(ZA) ASH

SAMPLE NUMBER:			ZA-AH-001	ZA-AH-002	ZA-AH-003	ZA-AH-003D	ZA-AH-004	ZA-AH-005
DILUTION FACTOR:								
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH	ASH
UNITS:			MG/KG	MG/KG	MG/KG		MG/KG	MG/KG
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		pH	11.83	11.85	11.79		11.80	11.68
		MOISTURE CONTENT %	0.9	1.9	1.6		1.1	1.7
		TOC	18100	22000	11400		23400	35600
		TOTAL SOLUBLE SOLIDS	52400	49800	50400		46500	48400
		AMMONIA	4.47	2.89	5.98		11.5	5.98
		NITRATE	2.86	2.29	2.22		2.54	4.23
		ORTHO PHOSPHATE	<0.05	<0.05	<0.05		<0.05	<0.05
		TOTAL ALKALINITY	7540	8000	7730		8100	8050
		CHLORIDE	18300	17800	23700		19100	16300
		SULFATE	5020	4800	6100		4620	3770
		ALUMINUM OXIDE %	8.52	9.37	9.0		9.23	9.85
		CALCIUM OXIDE %	20.5	20.3	22.2		15.1	18.4
		MAGNESIUM OXIDE %	1.38	1.33	1.31		1.50	1.21
		POTASSIUM MONOXIDE %	1.20	1.10	1.24		1.20	1.15
		SILICON DIOXIDE %	22.4	22.2	21.9		27.3	43.8

```
          (ZB) ASH

SAMPLE NUMBER:                              ZB-AH-001    ZB-AH-002    ZB-AH-003    ZB-AH-004    ZB-AH-005
DILUTION FACTOR:
DESCRIPTION:                                ASH          ASH          ASH          ASH          ASH
UNITS:                                      UG/KG
-----------------------------------         ------------ ------------ ------------ ------------ ------------

*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
---- ---------- ----------------

66B  117-81-7   BIS(2-ETHYLHEXYL)PHTHALATE   810JB        NA           NA           NA           NA
```

```
      (ZB) ASH

SAMPLE NUMBER:                          ZB-AH-001     ZB AH-002     ZB AH-003     ZB-AH-004     ZB AH-005
DILUTION FACTOR:
DESCRIPTION:                            ASH           ASH           ASH           ASH           ASH
UNITS:                                  UG/KG
-----------------------------------     ------------- ------------- ------------- ------------- -------------

*** ACIDS ***

 PP   CAS NO       COMPOUND
 ---  ----------  ----------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
```

(ZB) ASH

SAMPLE NUMBER:	ZB-AH-001	ZB-AH-002	ZB-AH-003	ZB-AH-004	ZB-AH-005
DILUTION FACTOR:					
DESCRIPTION:	ASH	ASH	ASH	ASH	ASH
UNITS:					
2378 TCDD	24				
TOTAL TCDD	375				
2378 TCDF	617				
TOTAL TCDF	4338				
12378 PeCDD	118				
TOTAL PeCDD	877				
12378 PeCDF	194				
23478 PeCDF	162				
TOTAL PeCDF	1883				
123478 HxCDD	40				
123678 HxCDD	34				
123789 HxCDD	79				
TOTAL HxCDD	495				
123478 HxCDF	336				
123678 HxCDF	524				
123789 HxCDF	127				
234678 HxCDF	54				
TOTAL HxCDF	1980				
1234678 HpCDD	319				
TOTAL HpCDD	607				
1234678 HpCDF	539				
1234789 HpCDF	48				
TOTAL HpCDF	784				
OCDD	544				
OCDF	243				

Dioxin Results are in pg/g

Note: Only 1 Ash Sample From This Facility Was Analyzed For Dioxins.

(ZB) ASH

SAMPLE NUMBER:			ZB-AH 001	ZB AH 002	ZB AH 003	ZB-AH 004	ZB-AH-005
DILUTION FACTOR:							
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH
UNITS:			MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
*** INORGANICS ***							
PP	CAS NO	COMPOUND					
3		ARSENIC	28	45	31	56	54
4		BARIUM	484	322	1000	260	283
6		CADMIUM	52	152	64	57	58
8		CHROMIUM	53	74	67	118	65
10		COPPER	9330	1370	674	842	4440
11		IRON	18800	19300	13600	21500	22200
12		LEAD	1070	1630	1490	1420	1740
14		MANGANESE	508	559	622	846	515
15		MERCURY	8.2	11	7.7	8.0	12
18		SELENIUM	5.7				
19		SILVER	6.9	9.4	6.0	10	5.4
20		SODIUM	8200	9210	8940	9810	10600
24		ZINC	8580	6480	4360	15800	6450

(ZB) ASH

SAMPLE NUMBER:	ZB-AH-001	ZB-AH-002	ZB-AH-003	ZB-AH-004	ZB-AH-005
DILUTION FACTOR:					
DESCRIPTION:	ASH	ASH	ASH	ASH	ASH
UNITS:	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZB-AH-001	ZB-AH-002	ZB-AH-003	ZB-AH-004	ZB-AH-005
		pH	11.48	10.91	11.49	11.59	11.67
		MOISTURE CONTENT %	4.5	5.1	2.7	3.8	8.8
		TOC	14600	29600	22800	29400	17000
		TOTAL SOLUBLE SOLIDS	36700	65800	44000	45300	55300
		AMMONIA	3.69	10.6	3.93	4.85	4.76
		NITRATE	2.65	2.75	1.45	2.09	2.87
		ORTHO PHOSPHATE	<0.05	<0.05	<0.05	<0.05	<0.05
		TOTAL ALKALINITY	4520	1590	5150	6650	6320
		CHLORIDE	18600	44200	19500	28000	31400
		SULFATE	963	764	3130	2440	1340
		ALUMINUM OXIDE %	8.46	10.3	9.35	9.26	7.39
		CALCIUM OXIDE %	19.4	22.3	21.2	20.6	25.7
		MAGNESIUM OXIDE %	1.40	1.62	1.45	1.54	1.19
		POTASSIUM MONOXIDE %	0.941	0.827	0.938	0.912	0.866
		SILICON DIOXIDE %	28.9	22.1	29.4	28.2	19.0

(ZC) ASH

SAMPLE NUMBER:			ZC-AH-001	ZC-AH-002	ZC-AH-003	ZC-AH-004	ZC-AH-005
DILUTION FACTOR:					1		
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH
UNITS:					UG/KG		
*** BASE/NEUTRALS ***							
PP	CAS NO	COMPOUND					
66B	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	310JB	NA	NA
68B	84-74-2	DI-N-BUTYL PHTHALATE	NA	NA	400JB	NA	NA

```
        (ZC) ASH

SAMPLE NUMBER:                       ZC AH-001     ZC AH 002     ZC-AH 003     ZC-AH-004     ZC-AH-005
DILUTION FACTOR:
DESCRIPTION:                         ASH           ASH           ASH           ASH           ASH
UNITS:                                                           UG/KG
----------------------------------   ------------- ------------- ------------- ------------- -------------

*** ACIDS ***

 PP   CAS NO       COMPOUND
---- ---------- ----------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
```

(ZC) ASH

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:	ZC-AH-001 ASH	ZC-AH-002 ASH	ZC-AH-003 ASH	ZC-AH-004 ASH	ZC-AH-005 ASH
2378 TCDD			16		
TOTAL TCDD			297		
2378 TCDF			236		
TOTAL TCDF			1444		
12378 PeCDD			71		
TOTAL PeCDD			1122		
12378 PeCDF			64		
23478 PeCDF			56		
TOTAL PeCDF			727		
123478 HxCDD			66		
123678 HxCDD			90		
123789 HxCDD			120		
TOTAL HxCDD			1201		
123478 HxCDF			218		
123678 HxCDF			279		
123789 HxCDF			193		
234678 HxCDF			70		
TOTAL HxCDF			1395		
1234678 HpCDD			1849		
TOTAL HpCDD			3360		
1234678 HpCDF			653		
1234789 HpCDF			83		
TOTAL HpCDF			990		
OCDD			6906		
OCDF			563		

Dioxin Results are in pg/g

Note: Only 1 Ash Sample From This Facility Was Analyzed For Dioxins.

(ZC) ASH

SAMPLE NUMBER:			ZC-AH-001	ZC-AH-002	ZC-AH-003	ZC-AH-004	ZC-AH-005
DILUTION FACTOR:							
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH
UNITS:			MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
*** INORGANICS ***							
PP	CAS NO	COMPOUND					
3		ARSENIC	31	36	30	28	29
4		BARIUM	213	193	248	314	331
6		CADMIUM	42	49	52	47	48
8		CHROMIUM	51	53	57	45	48
10		COPPER	1150	524	4470	758	547
11		IRON	21300	20000	23500	22100	25000
12		LEAD	2380	2580	1760	2630	1710
14		MANGANESE	1200	826	898	565	518
15		MERCURY	1.8	1.1	2.3	3.2	1.7
19		SILVER	8.8	12	5.8	5.6	6.0
20		SODIUM	8630	8940	7940	8040	7370
24		ZINC	4660	7170	4390	4180	4110

(ZC) ASH

SAMPLE NUMBER:	ZC-AH-001	ZC-AH-002	ZC-AH-003	ZC-AH-004	ZC-AH-005
DILUTION FACTOR:					
DESCRIPTION:	ASH	ASH	ASH	ASH	ASH
UNITS:	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND					
		pH	11.75	11.82	11.58	11.82	11.74
		MOISTURE CONTENT %	1.0	1.5	2.0	0.6	1.4
		TOC	9020	12300	14100	9830	17800
		TOTAL SOLUBLE SOLIDS	24600	22000	23600	23000	26100
		AMMONIA	1.49	1.86	1.40	1.33	2.10
		NITRATE	6.46	0.11	0.09	0.14	0.28
		ORTHO PHOSPHATE	<0.05	<0.05	<0.05	<0.05	<0.05
		TOTAL ALKALINITY	2690	2970	1210	2840	3040
		CHLORIDE	5180	3870	4180	5860	5280
		SULFATE	7870	5900	7400	9080	10300
		ALUMINUM OXIDE %	8.64	7.98	6.67	6.65	5.93
		CALCIUM OXIDE %	9.7	11.4	10.8	10.3	10.6
		MAGNESIUM OXIDE %	1.02	1.17	1.3	1.08	1.11
		POTASSIUM MONOXIDE %	0.875	1.07	1.04	1.03	0.992
		SILICON DIOXIDE %	62.9	53.8	48.4	57.0	49.5

(ZD) ASH

SAMPLE NUMBER:			ZD-AH-001	ZD-AH-002	ZD-AH-003	ZD-AH-004	ZD-AH-005
DILUTION FACTOR:					1		
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH
UNITS:					UG/KG		

*** BASE/NEUTRALS ***

PP	CAS NO	COMPOUND	ZD-AH-001	ZD-AH-002	ZD-AH-003	ZD-AH-004	ZD-AH-005
66B	117-81-7	BIS(2-ETHYLHEXYL)PHTHALATE	NA	NA	390JB	NA	NA
68B	84-74-2	DI-N-BUTYL PHTHALATE	NA	NA	270J	NA	NA
39B	206-44-0	FLUORANTHENE	NA	NA	170J	NA	NA
81B	85-01-8	PHENANTHRENE	NA	NA	310J	NA	NA

```
     (ZD) ASH

SAMPLE NUMBER:                             ZD-AH-001     ZD-AH-002     ZD-AH-003     ZD-AH-004     ZD-AH-005
DILUTION FACTOR:
DESCRIPTION:                               ASH           ASH           ASH           ASH           ASH
UNITS:                                                                 UG/KG
 --------------------------------          ------------- ------------- ------------- ------------- -------------

*** ACIDS ***

 PP   CAS NO      COMPOUND
---- ---------- ----------------


       NO PARAMETERS DETECTED FOR THIS CATEGORY
```

(ZD) ASH

SAMPLE NUMBER:	ZD-AH-001	ZD-AH-002	ZD-AH-003	ZD-AH-004	ZD-AH-005
DILUTION FACTOR:					
DESCRIPTION:	ASH	ASH	ASH	ASH	ASH
UNITS:					
2378 TCDD			35		
TOTAL TCDD			576		
2378 TCDF			626		
TOTAL TCDF			3259		
12378 PeCDD			ND		
TOTAL PeCDD			1910		
12378 PeCDF			151		
23478 PeCDF			171		
TOTAL PeCDF			2058		
123478 HxCDD			86		
123678 HxCDD			148		
123789 HxCDD			194		
TOTAL HxCDD			1281		
123478 HxCDF			654		
123678 HxCDF			660		
123789 HxCDF			479		
234678 HxCDF			124		
TOTAL HxCDF			3603		
1234678 HpCDD			1555		
TOTAL HpCDD			2939		
1234678 HpCDF			1842		
1234789 HpCDF			119		
TOTAL HpCDF			2345		
OCDD			4519		
OCDF			893		

Dioxin Results are in pg/g

Note: Only 1 Ash Sample From This Facility Was Analyzed For Dioxins.

(ZD) ASH

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:			ZD-AH-001 ASH MG/KG	ZD AH 002 ASH MG/KG	ZD-AH-003 ASH MG/KG	ZD-AH-004 ASH MG/KG	ZD-AH-005 ASH MG/KG
*** INORGANICS ***							
PP	CAS NO	COMPOUND					
3		ARSENIC	30	54	43	44	36
4		BARIUM	411	440	545	434	432
6		CADMIUM	51	66	69	42	39
8		CHROMIUM	87	199	70	54	52
10		COPPER	1050	960	1490	959	1800
11		IRON	34600	37100	27400	31100	22900
12		LEAD	4090	5040	2980	2860	22400
14		MANGANESE	574	609	618	965	636
15		MERCURY	0.91	1.5	2.1	0.55	0.97
18		SELENIUM	2.9		3.1	3.9	3.2
19		SILVER	7.5	9.4	11	6.3	7.6
20		SODIUM	6050	6480	6500	6100	5890
24		ZINC	5660	6560	8000	4930	4260

(ZD) ASH

	ZD-AH-001	ZD-AH-002	ZD-AH-003	ZD-AH-004	ZD-AH-005
SAMPLE NUMBER:	ZD-AH-001	ZD-AH-002	ZD-AH-003	ZD-AH-004	ZD-AH-005
DILUTION FACTOR:					
DESCRIPTION:	ASH	ASH	ASH	ASH	ASH
UNITS:	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
*** GEOCHEMICAL PARAMETERS ***					
PP CAS NO COMPOUND					
pH	10.69	10.60	10.51	10.36	10.46
MOISTURE CONTENT %	0.4	1.6	1.2	1.2	0.9
TOC	25800	30000	52100	11400	53200
TOTAL SOLUBLE SOLIDS	6850	13200	6440	8740	7150
AMMONIA	1.00	1.04	1.02	0.90	1.08
NITRATE	1.59	1.14	0.44	0.96	0.72
ORTHO PHOSPHATE	<0.05	0.05	0.05	0.05	0.05
TOTAL ALKALINITY	852	558	786	852	922
CHLORIDE	1270	2190	766	854	869
SULFATE	2220	5580	1680	2360	1800
ALUMINUM OXIDE %	12	12	13	9.9	11
CALCIUM OXIDE %	11	11	10	12	11
MAGNESIUM OXIDE %	2.0	1.9	2.2	2.2	1.8
POTASSIUM MONOXIDE %	1.4	1.1	0.79	1.1	0.98
SILICON DIOXIDE %	35	37	35	32	36

```
        (ZE) ASH

SAMPLE NUMBER:                           ZE-AH-001     ZE-AH-002     ZE-AH-003     ZE-AH-004     ZE-AH-005
DILUTION FACTOR:
DESCRIPTION:                             ASH           ASH           ASH           ASH           ASH
UNITS:
-----------------------------------      ------------- ------------- ------------- ------------- -------------

*** BASE/NEUTRALS ***

 PP   CAS NO      COMPOUND
---- ---------- ----------------


        NO PARAMETERS DETECTED FOR THIS CATEGORY
```

```
          (ZE) ASH

SAMPLE NUMBER:                        ZE-AH-001   ZE-AH-002   ZE-AH-003   ZE-AH-004   ZE-AH-005
DILUTION FACTOR:
DESCRIPTION:                          ASH         ASH         ASH         ASH         ASH
UNITS:
------------------------------        ----------- ----------- ----------- ----------- -----------

*** ACIDS ***

 PP   CAS NO      COMPOUND
---- ---------- --------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
```

```
              (ZE) ASH

SAMPLE NUMBER:                                  ZE-AH-001      ZE-AH-002      ZE-AH-003      ZE-AH-004      ZE-AH-005
DILUTION FACTOR:
DESCRIPTION:                                    ASH            ASH            ASH            ASH            ASH
UNITS:
-----------------------------------             -------------- -------------- -------------- -------------- --------------

*** PESTICIDES ***

 PP   CAS NO       COMPOUND
---- ---------- ----------------

                DICHLOROBIPHENYL                  NA             NA             98             NA             NA
```

(ZE) ASH

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:	ZE-AH-001 ASH	ZE-AH-002 ASH	ZE-AH-003 ASH	ZE-AH-004 ASH	ZE-AH-005 ASH
2378 TCDD			10		
TOTAL TCDD			130		
2378 TCDF			176		
TOTAL TCDF			1312		
12378 PeCDD			35		
TOTAL PeCDD			283		
12378 PeCDF			52		
23478 PeCDF			43		
TOTAL PeCDF			543		
123478 HxCDD			11		
123678 HxCDD			11		
123789 HxCDD			22		
TOTAL HxCDD			148		
123478 HxCDF			95		
123678 HxCDF			134		
123789 HxCDF			45		
234678 HxCDF			20		
TOTAL HxCDF			574		
1234678 HpCDD			122		
TOTAL HpCDD			122		
1234678 HpCDF			155		
1234789 HpCDF			16		
TOTAL HpCDF			215		
OCDD			294		
OCDF			59		

Dioxin Results are in pg/g

Note: Only 1 Ash Sample From This Facility Was Analyzed For Dioxins.

(ZE) ASH

SAMPLE NUMBER:			ZE-AH-001	ZE-AH-002	ZE-AH-003	ZE-AH-004	ZE-AH-005
DILUTION FACTOR:							
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH
UNITS:			MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
*** INORGANICS ***							
PP	CAS NO	COMPOUND					
3		ARSENIC	16	17	19	15	20
4		BARIUM	407	491	505	391	792
6		CADMIUM	34	35	38	37	18
8		CHROMIUM	665	71	87	67	70
10		COPPER	990	1300	1820	1500	930
11		IRON	34600	43000	45100	40200	33900
12		LEAD	1550	1380	1170	1170	1600
14		MANGANESE	593	640	531	598	581
15		MERCURY	7.6	4.7	13	4.8	3.2
18		SELENIUM				4.7	
19		SILVER	4.4	5.6	5.4	13	11
20		SODIUM	6750	6410	7500	5880	7700
24		ZINC	8280	3530	3600	3400	2120

(ZE) ASH

SAMPLE NUMBER:			ZE-AH-001	ZE-AH-002	ZE-AH-003	ZE-AH-004	ZE-AH-005
DILUTION FACTOR:							
DESCRIPTION:			ASH	ASH	ASH	ASH	ASH
UNITS:			MG/KG	MG/KG	MG/KG	MG/KG	MG/KG

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZE-AH-001	ZE-AH-002	ZE-AH-003	ZE-AH-004	ZE-AH-005
		pH	11.61	11.69	11.71	11.40	11.82
		MOISTURE CONTENT %	2.5	1.9	1.4	1.3	0.6
		TOC	34000	8920	4060	7290	43300
		TOTAL SOLUBLE SOLIDS	22900	25900	35500	26100	11200
		AMMONIA	5.05	3.64	8.69	7.32	2.77
		NITRATE	2.90	3.19	4.51	4.10	4.23
		ORTHO PHOSPHATE	<0.05	<0.05	<0.05	<0.05	<0.05
		TOTAL ALKALINITY	3490	4710	2990	7310	7590
		CHLORIDE	9220	10900	14100	10400	7550
		SULFATE	2190	1500	2790	2530	2270
		ALUMINUM OXIDE %	11	9.7	10	10	10
		CALCIUM OXIDE %	15	14	13	14	13
		MAGNESIUM OXIDE %	2.0	1.6	1.9	1.8	1.6
		POTASSIUM MONOXIDE %	1.2	1.2	1.4	0.95	1.0
		SILICON DIOXIDE %	31	31	35	30	32

C

APPENDIX C

LEACHATE RESULTS

(FACILITIES ZB, ZC, ZD, ZE)

```
        (ZB) LEACHATE

SAMPLE NUMBER:                            ZB LE 001     ZB LE 002
DILUTION FACTOR:
DESCRIPTION:                              LEACHATE      LEACHATE
UNITS:
------------------------------------     -----------   -----------

*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
---- ---------- -----------------


     NO PARAMETERS DETECTED FOR THIS CATEGORY
```

```
        (ZB) LEACHATE

SAMPLE NUMBER:                              ZB-LE 001    ZB LE 002
DILUTION FACTOR:
DESCRIPTION:                                LEACHATE     LEACHATE
UNITS:
 ----------------------------------         ------------------------

*** ACIDS ***

 PP    CAS NO       COMPOUND
 ---------------------------------

      NO PARAMETERS DETECTED FOR THIS CATEGORY
```

```
         (ZB) LEACHATE

SAMPLE NUMBER:                          ZB LE-001      ZB LE 002
DILUTION FACTOR:
DESCRIPTION:                            LEACHATE       LEACHATE
UNITS:                                  UG/L           UG/L
-----------------------------------     -------------- ----------

*** INORGANICS ***

 PP    CAS NO        COMPOUND
---- ----------- ----------------

1               ALUMINUM                               19
4               BARIUM                  9220           64
6               CADMIUM                 4.0
7               CALCIUM                 8390000        112000
10              COPPER                  8.8            5.4
11              IRON                    840
13              MAGNESIUM               17300          15700
14              MANGANESE               17600          6.7
17              POTASSIUM               1620000        10900
20              SODIUM                  2450000        14000
24              ZINC                    8.3            7.5
                SILICON                 3150           3590
```

```
          (ZB) LEACHATE

SAMPLE NUMBER:                                ZB-LE-001     ZB-LE-002
DILUTION FACTOR:
DESCRIPTION:                                  LEACHATE      LEACHATE
UNITS:                                        MG/L          MG/L
-----------------------------------           ------------- -------------

*** GEOCHEMICAL PARAMETERS ***

 PP    CAS NO       COMPOUND
---- ---------- ---------------

                TOC                            30.0          10.6
                AMMONIA                        4.18          <0.05
                NITRATE                        0.45          0.01
                ORTHO PHOSPHATE                0.01          <0.01
                TOTAL ALKALINITY               65.0          154
                SULFATE                        171           197
                TDS                            40600         535
                FIELD PH                       6.5           6.5
                SPECIFIC CONDUCTIVITY UMHOS/CM >10000        880
                TEMPERATURE (C)                9             5
```

```
        (ZC) LEACHATE

SAMPLE NUMBER:                          ZC-LE-001     ZC-LE-002
DILUTION FACTOR:
DESCRIPTION:                            LEACHATE      LEACHATE
UNITS:
-----------------------------------     ------------- -------------

*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
 ---  ----------  ----------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
```

```
        (ZC) LEACHATE

SAMPLE NUMBER:                          .          ZC-LE-001      ZC-LE-002
DILUTION FACTOR:
DESCRIPTION:                                       LEACHATE       LEACHATE
UNITS:
-----------------------------------               ----------- -- -----------

*** ACIDS ***

 PP    CAS NO       COMPOUND
 --  ---------- ----------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
```

(ZC) LEACHATE

			ZC LE-001	ZC LE 002
SAMPLE NUMBER:			ZC LE-001	ZC LE 002
DILUTION FACTOR:				
DESCRIPTION:			LEACHATE	LEACHATE
UNITS:			UG/L	UG/L
*** INORGANICS ***				
PP	CAS NO	COMPOUND		
4		BARIUM	7.8	8.0
7		CALCIUM	64600	65800
11		IRON	108	115
12		LEAD		34
13		MAGNESIUM	22600	23000
14		MANGANESE	493	501
17		POTASSIUM	79700	81200
20		SODIUM	188000	191000
24		ZINC	13	9.0
		SILICON	4570	4840

(ZC) LEACHATE

SAMPLE NUMBER:			ZC-LE-001	ZC-LE-002
DILUTION FACTOR:				
DESCRIPTION:			LEACHATE	LEACHATE
UNITS:			MG/L	MG/L

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND		
		TOC	47.2	49.3
		AMMONIA	68.2	77.4
		NITRATE	0.40	0.41
		ORTHO PHOSPHATE	<0.01	<0.01
		TOTAL ALKALINITY	560	566
		SULFATE	14.5	14.4
		TDS	924	932
		FIELD PH	6.9	
		SPECIFIC CONDUCTIVITY UMHOS/CM	1800	
		TEMPERATURE (C)	21	

```
         (ZD) LEACHATE

SAMPLE NUMBER:                                    ZD-LE-001     ZD-LE 002     ZD-LE 003
DILUTION FACTOR:
DESCRIPTION:                                      LEACHATE      LEACHATE      LEACHATE
UNITS:
 -----------------------------------              ------------- ------------- -------------

*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
---- ----------- ----------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
```

```
        (ZD) LEACHATE

SAMPLE NUMBER:                          ZD-LE-001      ZD-LE-002      ZD-LE-003
DILUTION FACTOR:
DESCRIPTION:                            LEACHATE       LEACHATE       LEACHATE
UNITS:
 ----------------------------------     -------------- -------------- --------------

*** ACIDS ***

 PP   CAS NO       COMPOUND
---- ----------- ----------------


     NO PARAMETERS DETECTED FOR THIS CATEGORY
```

(ZD) LEACHATE

SAMPLE NUMBER:			ZD-LE 001	ZD LE-002	ZD LE-003
DILUTION FACTOR:					
DESCRIPTION:			LEACHATE	LEACHATE	LEACHATE
UNITS:			UG/L	UG/L	UG/L
*** INORGANICS ***					
PP	CAS NO	COMPOUND			
4		BARIUM	40	18	38
7		CALCIUM	477000	386000	470000
10		COPPER	12	4.6	7.3
11		IRON	187	523	211
13		MAGNESIUM	345000	367000	340000
14		MANGANESE	795	718	857
17		POTASSIUM	636000	229000	632000
20		SODIUM	2480000	1340000	2580000
24		ZINC	8.7		5.2
		SILICON	15300	8760	14900

(ZD) LEACHATE

SAMPLE NUMBER:	ZD-LE-001	ZD LE-002	ZD-LE-003
DILUTION FACTOR:			
DESCRIPTION:	LEACHATE	LEACHATE	LEACHATE
UNITS:	MG/L	MG/L	MG/L

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZD-LE-001	ZD LE-002	ZD-LE-003
		TOC	28.8	30.7	NA
		AMMONIA	4.38	28.4	NA
		NITRATE	0.04	<0.01	<0.01
		ORTHO PHOSPHATE	0.24	0.17	0.22
		TOTAL ALKALINITY	709	744	711
		SULFATE	4920	4140	5080
		TDS	12700	8030	13000
		FIELD PH *	[redacted]	[redacted]	[redacted]
		SPECIFIC CONDUCTIVITY UMHOS/CM	>10000	9400	>10000
		TEMPERATURE (C)	30	19	30

* pH meter not working properly.

```
         (ZE) LEACHATE

SAMPLE NUMBER:                                 ZE-LE-001      ZE-LE-002
DILUTION FACTOR:                               1              1
DESCRIPTION:                                   LEACHATE       LEACHATE
UNITS:                                         UG/L           UG/L
-----------------------------------            -------------- --------------

*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------

      65-85-0   BENZOIC ACID                   73             52
```

```
        (ZE) LEACHATE

SAMPLE NUMBER:                                ZE-LE-001     ZE-LE-002
DILUTION FACTOR:
DESCRIPTION:                                  LEACHATE      LEACHATE
UNITS:                                        UG/L          UG/L
-----------------------------------           ------------  ------------

*** ACIDS ***

 PP    CAS NO        COMPOUND
----  ----------  ----------------


        NO PARAMETERS DETECTED FOR THIS CATEGORY
        (ZE) LEACHATE

SAMPLE NUMBER:                              ZE-LE-001      ZE-LE-002
DILUTION FACTOR:
DESCRIPTION:                                LEACHATE       LEACHATE
UNITS:                                      UG/L           UG/L
-----------------------------------         -------------- --------------

*** INORGANICS ***

 PP    CAS NO        COMPOUND
---- ---------- ----------------

1                BARIUM                      3080           2970
7                CALCIUM                     5670000        5570000
11               IRON                        10500          7480
13               MAGNESIUM                   14800          15000
14               MANGANESE                   17100          18500
17               POTASSIUM                   1430000        1450000
20               SODIUM                      2430000        2470000
24               ZINC                        27             70
                 SILICON                     498            470
```

```
            (ZE) LEACHATE

SAMPLE NUMBER:                           ZE-LE-001      ZE-LE-002
DILUTION FACTOR:
DESCRIPTION:                             LEACHATE       LEACHATE
UNITS:                                   MG/L           MG/L
-----------------------------------      -------------- --------------

*** GEOCHEMICAL PARAMETERS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------

                TOC                       28.9           25.5
                AMMONIA                   9.78           11.4
                NITRATE                   0.01           0.01
                ORTHO PHOSPHATE           <0.01          <0.01
                TOTAL ALKALINITY          95.2           117
                SULFATE                   312            309
                TDS                       26300          25900
                FIELD PH                  5.2
                SPECIFIC CONDUCTIVITY UMHOS/CM >10000
                TEMPERATURE (C)           23
```

D

APPENDIX D

ASH EXTRACT RESULTS

```
SAMPLE NUMBER:                             ZA-AH-001CO2   ZA-AH-001DIH2O ZA-AH-001EPTOX ZA-AH-001SAR   ZA-AH-001TCLP1 ZA-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                               ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
------------------------------------       -------------- -------------- -------------- -------------- -------------- --------------

*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
---- ---------- ----------------

     65-85-0    BENZOIC ACID                                 130
```

```
SAMPLE NUMBER:                         ZA-AH-001CO2   ZA-AH-001DIH2O ZA-AH-001EPTOX ZA-AH-001SAR   ZA-AH-001TCLP1 ZA-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                           ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
-----------------------------------    -------------- -------------- -------------- -------------- -------------- --------------

*** ACIDS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


        NO PARAMETERS DETECTED FOR THIS CATEGORY
```

SAMPLE NUMBER:			ZA AH 001CO2	ZA AH-001DIH2O	ZA-AH-001LPTON	ZA-AH-001SAR	ZA-AH-001TCLP1	ZA-AH-001TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L

*** INORGANICS ***

PP	CAS NO	COMPOUND	ZA AH 001CO2	ZA AH-001DIH2O	ZA-AH-001LPTON	ZA-AH-001SAR	ZA-AH-001TCLP1	ZA-AH-001TCLP2
1		BARIUM	260	527	455	188	616	700
6		CADMIUM	108	1.6	663			136
8		CHROMIUM		6.8	47	10		12
10		COPPER	419	181	1110	148	101	9.4
11		IRON	10	61	21700		16	75400
12		LEAD	40	2200	6110	2200		110
14		MANGANESE	2260	6.4	1030		1.1	5410
15		MERCURY	1.0		55	0.81	0.13	
18		SELENIUM				6.1		
20		SODIUM	108000	130000	126000	108000	1520000	140000
21		ZINC	28200	892	71100	697	62	76000

SAMPLE NUMBER:	ZA-AH-001CO2	ZA-AH-001DIH2O	ZA-AH-001EPTOX	ZA-AH-001SAR	ZA-AH-001TCLP1	ZA-AH-001TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:					UG/L	

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND						
		TOC	21.2	17.1	2500	15.0	2110	2230
		AMMONIA	0.33	0.21	0.31	0.89	0.31	0.20
		NITRATE	0.15	0.12	0.12	3.11	0.13	0.10
		ORTHO PHOSPHATE	<0.01	<0.01	0.34	<0.01	<0.02	<0.02
		TOTAL ALKALINITY	1210	908	1450	856	2390	2130
		CHLORIDE	773	950	854	840	971	1030
		SULFATE	896	516	1120	507	552	1110
		ALUMINUM OXIDE %	251	195	18100	166	3100	112
		CALCIUM OXIDE %	693000	684000	3030000	1100000	669000	2930000
		MAGNESIUM OXIDE %	32000	124	58900	18	400	66900
		POTASSIUM MONOXIDE %	111000	111000	128000	121000	163000	142000
		SILICON DIOXIDE %	62100	715	98700	875	5520	6320
		TDS	3920	3220	9720	2970	8820	10200

```
          (ZA002) ASH EXTRACT

SAMPLE NUMBER:                                ZA-AH-002CO2   ZA-AH-002DIH2O ZA-AH-002EPTOX ZA-AH-002SAR   ZA-AH-002TCLP1 ZA-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                                  ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
-----------------------------------           -------------- -------------- -------------- -------------- -------------- --------------

*** BASE/NEUTRALS ***

 PP    CAS NO        COMPOUND
---- ---------- ----------------

        NO PARAMETERS DETECTED FOR THIS CATEGORY
```

```
          (ZA002) ASH EXTRACT

SAMPLE NUMBER:                               ZA-AH-002CO2   ZA-AH-002DIH2O ZA-AH-002EPTOX ZA-AH-002SAR   ZA-AH-002TCLP1 ZA-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                                 ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
------------------------------------         -------------- -------------- -------------- -------------- -------------- --------------

*** ACIDS ***

 PP   CAS NO       COMPOUND
---- ---------- ----------------


       NO PARAMETERS DETECTED FOR THIS CATEGORY
```

(ZA002) ASH EXTRACT

SAMPLE NUMBER:			ZA-AH-002CO2	ZA-AH-002DIH2O	ZA-AH-002EPTOX	ZA-AH-002SAR	ZA-AH-002TCLP1	ZA-AH-002TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
1		BARIUM	268	457	177	464	651	643
6		CADMIUM	83	7.6	750			
8		CHROMIUM	4.2	10	6.0	9.2		
10		COPPER	436	274	790	291	301	213
11		IRON	301	63	14		6.6	20
12		LEAD		1960	94	2670	360	
14		MANGANESE	1930	5.0	2750			3.8
15		MERCURY	155		203		0.24	0.56
18		SELENIUM				23		
20		SODIUM	152000	174000	150000	160000	1490000	228000
21		ZINC	22700	810	37800	814	106	31

(ZA002) ASH EXTRACT

SAMPLE NUMBER:	ZA-AH-002CO2	ZA-AH-002DIH2O	ZA-AH-002EPTOX	ZA-AH-002SAR	ZA-AH-002TCLP1	ZA-AH-002TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZA-AH-002CO2	ZA-AH-002DIH2O	ZA-AH-002EPTOX	ZA-AH-002SAR	ZA-AH-002TCLP1	ZA-AH-002TCLP2
		TOC	55.4	33.9	2490	33.4	2330	2240
		AMMONIA	0.26	0.21	0.27	1.00	0.22	0.28
		NITRATE	0.19	0.14	0.14	3.04	0.14	0.14
		ORTHO PHOSPHATE	0.06	<0.01	<0.01	<0.01	<0.01	<0.01
		TOTAL ALKALINITY	1630	1590	2630	1710	3060	2390
		CHLORIDE	1040	1170	1020	1200	1080	1410
		SULFATE	856	603	1190	627	567	617
		ALUMINUM OXIDE %	302	<38	<20	<28	238	1850
		CALCIUM OXIDE %	697000	699000	2330000	1800000	2220000	3240000
		MAGNESIUM OXIDE %	39100	124	27300	12	74	623
		POTASSIUM MONOXIDE %	143000	168000	104000	160000	179000	224000
		SILICON DIOXIDE %	71800	616	29000	364	2850	5950
		TDS	4860	1220	11800	4420	9620	10900

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        (ZA003) ASH EXTRACT

SAMPLE NUMBER:                           ZA-AH-003CO2   ZA-AH-003DIH2O ZA-AH-003EPTOX ZA-AH-003SAR   ZA-AH-003TCLP1 ZA-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                             ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZA003) ASH EXTRACT

SAMPLE NUMBER:                         ZA-AH-003CO2   ZA-AH-003DIH2O ZA-AH-003EPTOX ZA-AH-003SAR   ZA-AH-003TCLP1 ZA-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                           ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZA003) ASH EXTRACT

SAMPLE NUMBER:			ZA-AH-003CO2	ZA-AH-003DIH2O	ZA-AH-003EPTOX	ZA-AH-003SAR	ZA-AH-003TCLP1	ZA-AH-003TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC			31			
4		BARIUM	218	557	300	518	595	809
6		CADMIUM	85		1000			695
8		CHROMIUM		9.8	72			13
10		COPPER	340	160	1380	128	163	33
11		IRON	249	37	12000		15	41400
12		LEAD		3410	11300	3940	996	81
14		MANGANESE	2260		3190			3960
15		MERCURY	24		61	0.20		0.88
20		SODIUM	123000	139000	108000	116000	1520000	123000
21		ZINC	34100	1340	75900	1290	377	76400

(ZA003) ASH EXTRACT

SAMPLE NUMBER:			ZA-AH-003CO2	ZA-AH-003DIH2O	ZA-AH-003EPTOX	ZA-AH-003SAR	ZA-AH-003TCLP1	ZA-AH-003TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		TOC	23.9	15.3	2460	12.8	2040	2250
		AMMONIA	0.35	0.28	0.35	0.90	0.38	0.22
		NITRATE	0.13	0.12	0.11	3.20	0.14	0.07
		ORTHO PHOSPHATE	0.02	<0.01	0.94	<0.01	<0.02	<0.01
		TOTAL ALKALINITY	1560	1120	1550	1100	2500	2340
		CHLORIDE	1040	1080	890	1030	1250	965
		SULFATE	1050	552	1320	530	527	1100
		ALUMINUM OXIDE %	300	71	29300	73	223	1580
		CALCIUM OXIDE %	694000	695000	3050000	1340000	2380000	3070000
		MAGNESIUM OXIDE %	35000	57	56000	18	110	62300
		POTASSIUM MONOXIDE %	136000	164000	119000	140000	210000	133000
		SILICON DIOXIDE %	36600	1640	69400	490	2790	3780
		TDS	4890	3620	9620	3630	9420	11000

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        (ZA004) ASH EXTRACT

SAMPLE NUMBER:                                    ZA-AH-004CO2   ZA-AH-004DIH2O ZA-AH-004EPTOX ZA-AH-004SAR   ZA-AH-004TCLP1 ZA-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                                      ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO        COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZA004) ASH EXTRACT

SAMPLE NUMBER:                         ZA-AH-004CO2   ZA-AH-004DIH2O ZA-AH-004EPTOX ZA-AH-004SAR   ZA-AH-004TCLP1 ZA-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                           ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZA004) ASH EXTRACT

SAMPLE NUMBER:			ZA-AH-004C02	ZA-AH-004DIH2O	ZA-AH-004EPTOX	ZA-AH-004SAR	ZA-AH-004TCLP1	ZA-AH-004TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
1		BARIUM	282	548	302	548	592	149
6		CADMIUM	65		592			48
8		CHROMIUM		8.5	37	8.8		20
10		COPPER	268	477	2620	538	167	7.6
11		IRON	43	21	10800		12	49100
12		LEAD		2210	6390	2800		171
14		MANGANESE	2390		3010	2.5		2660
15		MERCURY			24		3.8	
18		SELENIUM				8.0		
20		SODIUM	141000	135000	108000	121000	1460000	71700
21		ZINC	32000	651	51800	1010	12	37700

(ZA004) ASH EXTRACT

SAMPLE NUMBER:	ZA-AH-004CO2	ZA-AH-004DIH2O	ZA-AH-004EPTOX	ZA-AH-004SAR	ZA-AH-004TCLP1	ZA-AH-004TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZA-AH-004CO2	ZA-AH-004DIH2O	ZA-AH-004EPTOX	ZA-AH-004SAR	ZA-AH-004TCLP1	ZA-AH-004TCLP2
		TOC	34.9	26.2	2210	27.3	2100	2200
		AMMONIA	0.44	0.27	0.45	1.00	0.37	0.22
		NITRATE	0.16	0.13	0.20	3.25	0.14	0.16
		ORTHO PHOSPHATE	0.06	<0.01	0.13	<0.01	<0.02	<0.01
		TOTAL ALKALINITY	1600	910	1250	1060	2530	3350
		CHLORIDE	960	802	748	901	1020	686
		SULFATE	832	129	917	512	489	980
		ALUMINUM OXIDE %	179	146	16100	94	1170	798
		CALCIUM OXIDE %	699000	684000	2500000	1190000	674000	692000
		MAGNESIUM OXIDE %	42800	50	50800	18	219	43500
		POTASSIUM MONOXIDE %	134000	134000	10100	118000	157000	63300
		SILICON DIOXIDE %	57000	1060	75300	877	4710	1360
		TDS	4660	2890	8090	3270	9050	9230

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          (ZA005) ASH EXTRACT

SAMPLE NUMBER:                              ZA-AH-005CO2   ZA-AH-005DIH2O ZA-AH-005EPTOX ZA-AH-005SAR   ZA-AH-005TCLP1 ZA-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                                ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
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     NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZA005) ASH EXTRACT

SAMPLE NUMBER:                             ZA-AH-005CO2   ZA-AH-005DIH2O ZA-AH-005EPTOX ZA-AH-005SAR   ZA-AH-005TCLP1 ZA-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                               ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP   CAS NO        COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZA005) ASH EXTRACT

SAMPLE NUMBER:			ZA-AH 005C02	ZA-AH-005DIH2O	ZA-AH 005EPTOX	ZA AH 005SAR	ZA-AH-005TCLP1	ZA-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
4		BARIUM	257	520	398	561	505	798
6		CADMIUM	63	6.9	677			455
8		CHROMIUM	5.1	8.4	48	8.5		16
10		COPPER	620	534	791	610	196	27
11		IRON	168	115	9630		12	28800
12		LEAD		3070	4450	1740	271	174
14		MANGANESE	1540	20	2450	2.8		2920
15		MERCURY	8.9		23			0.24
18		SELENIUM				7.1		
19		SILVER	16					
20		SODIUM	133000	137000	146000	150000	1450000	129000
24		ZINC	23100	1070	54500	690	163	78500

(ZA005) ASH EXTRACT

SAMPLE NUMBER:			ZA-AH-005CO2	ZA-AH-005DIH2O	ZA-AH-005EPTOX	ZA-AH-005SAR	ZA-AH-005TCLP1	ZA-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		TOC	64.2	43.5	2520	42.5	2340	2400
		AMMONIA	0.21	0.26	0.40	1.03	0.34	<0.10
		NITRATE	0.30	0.20	0.21	3.21	0.18	0.16
		ORTHO PHOSPHATE	0.09	<0.01	0.47	<0.01	<0.01	<0.01
		TOTAL ALKALINITY	1590	1440	2090	1330	3050	2310
		CHLORIDE	1030	968	1160	1180	1020	869
		SULFATE	958	550	1130	547	529	1080
		ALUMINUM OXIDE %	258	81	12600	50	305	180
		CALCIUM OXIDE %	697000	698000	3580000	1620000	677000	3540000
		MAGNESIUM OXIDE %	33500	379	58800	15	92	55400
		POTASSIUM MONOXIDE %	139000	148000	154000	168000	143000	128000
		SILICON DIOXIDE %	65100	694	98700	561	3600	81100
		TDS	1740	3850	11100	4100	10700	11100

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          (ZB001) ASH EXTRACT

SAMPLE NUMBER:                                ZB-AH-001CO2   ZB-AH-001DIH2O ZB-AH-001EPTOX ZB-AH-001SAR   ZB-AH-001TCLP1 ZB-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                                  ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


        NO PARAMETERS DETECTED FOR THIS CATEGORY
        (ZB001) ASH EXTRACT

SAMPLE NUMBER:
DILUTION FACTOR:                   ZB-AH-001CO2   ZB-AH-001DIH2O ZB-AH-001EPTOX ZB-AH-001SAR   ZB-AH-001TCLP1 ZB-AH-001TCLP2
DESCRIPTION:                       ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP   CAS NO      COMPOUND
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       NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZB001) ASH EXTRACT

SAMPLE NUMBER:			ZB-AH-001CO2	ZB-AH-001DIH2O	ZB-AH-001EPTOX	ZB-AH-001SAR	ZB-AH-001TCLP1	ZB-AH-001TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
4		BARIUM	126	2590	182	3960	498	467
6		CADMIUM	9.2		301			118
10		COPPER	30	18	803	64	19	5.4
11		IRON						3360
12		LEAD		29	19			
14		MANGANESE	11		1790		5.8	2060
15		MERCURY			0.73		0.25	0.37
20		SODIUM	111000	123000	128000	138000	1410000	116000
24		ZINC	13	54	9630	54	30	6110

(ZB001) ASH EXTRACT

PP	CAS NO	COMPOUND						
		SAMPLE NUMBER:	ZB-AH-001CO2	ZB-AH-001DIH2O	ZB-AH-001EPTOX	ZB-AH-001SAR	ZB-AH-001TCLP1	ZB-AH-001TCLP2
		DILUTION FACTOR:						
		DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
		UNITS:						
		*** GEOCHEMICAL PARAMETERS ***						
		TOC	NA	6.52	NA	11.5	NA	NA
		AMMONIA	NA	0.18	NA	NA	NA	NA
		NITRATE	0.36	0.24	0.13	NA	0.31	0.30
		ORTHO PHOSPHATE	0.01	<0.01	1.32	<0.01	0.01	1.75
		TOTAL ALKALINITY	NA	337	NA	NA	NA	NA
		CHLORIDE	1300	1200	2160	NA	1490	1270
		SULFATE	513	3.6	556	NA	363	728
		ALUMINUM OXIDE %	4990	4850		30400	62800	
		CALCIUM OXIDE %	909000	810000	3240000	817000	1970000	3210000
		MAGNESIUM OXIDE %	24600	24	127000	36	920	117000
		POTASSIUM MONOXIDE %	99200	108000	101000	111000	122000	100000
		SILICON DIOXIDE %	1280	1470	32900	1420	473	42600
		TDS	NA	2180	NA	NA	NA	NA

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              (ZB002) ASH EXTRACT

SAMPLE NUMBER:                                    ZB-AH-002CO2   ZB-AH-002DIH2O ZB-AH-002EPTOX ZB-AH-002SAR   ZB-AH-002TCLP1 ZB-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                                      ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


        NO PARAMETERS DETECTED FOR THIS CATEGORY
        (ZB002) ASH EXTRACT

SAMPLE NUMBER:                            ZB-AH-002CO2   ZB-AH-002DIH2O ZB-AH-002EPTOX ZB-AH-002SAR   ZB-AH-002TCLP1 ZB-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                              ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO        COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
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                (ZB002) ASH EXTRACT

SAMPLE NUMBER:                            ZB-AH-002C02   ZB AH 002DIH20 ZB-AH-002EPTOX ZB-AH-002SAR   ZB-AH-002TCLP1 ZB-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                              ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:                                    UG/L           UG/L           UG/L           UG/L           UG/L           UG/L
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*** INORGANICS ***

 PP    CAS NO      COMPOUND
---- ---------- ---------------

4                 BARIUM                  249            3050           350            2770           693            511
6                 CADMIUM                                               485                                          833
10                COPPER                  27             35             70             21             36             262
11                IRON                                                                                               1590
11                MANGANESE               8.2                           1150                          5.8            2250
15                MERCURY                                               0.90                                         1.2
20                SODIUM                  168000         209000         225000         201000         1450000        141000
21                ZINC                    5.0            44             1330           20             11             10000
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        (ZB002) ASH EXTRACT

SAMPLE NUMBER:                              ZB-AH-002CO2    ZB-AH-002DIH2O  ZB-AH-002EPTOX  ZB-AH-002SAR    ZB-AH-002TCLP1  ZB-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                                ASH EXTRACT     ASH EXTRACT     ASH EXTRACT     ASH EXTRACT     ASH EXTRACT     ASH EXTRACT
UNITS:
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*** GEOCHEMICAL PARAMETERS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------

                  TOC                       NA              5.92            NA              7.54            NA              NA
                  AMMONIA                   NA              0.28            NA              NA              NA              NA
                  NITRATE                   0.33            0.17            0.31            NA              0.16            0.15
                  ORTHO PHOSPHATE           <0.01           <0.01           0.10            <0.01           <0.01           0.01
                  TOTAL ALKALINITY          NA              285             NA              NA              NA              NA
                  CHLORIDE                  2930            3040            3440            NA              3500            2720
                  SULFATE                   507             2.6             922             NA              524             674
                  ALUMINUM OXIDE %          26200           48400                           102000          62300
                  CALCIUM OXIDE %           1920000         1740000         4810000         1690000         2750000         3610000
                  MAGNESIUM OXIDE %         5880            68              130000          65              887             12400
                  POTASSIUM MONOXIDE %      155000          189000          189000          167000          170000          127000
                  SILICON DIOXIDE %         599             611             21500           511             379             79000
                  TDS                       NA              1310            NA              NA              NA              NA
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          (ZB003) ASH EXTRACT

SAMPLE NUMBER:                              ZB-AH-003CO2   ZB-AH-003DIH2O ZB-AH-003EPTOX ZB-AH-003SAR   ZB-AH-003TCLP1 ZB-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                                ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


       NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZB003) ASH EXTRACT

SAMPLE NUMBER:                          ZB-AH-003CO2   ZB-AH-003DIH2O ZB-AH-003EPTOX ZB-AH-003SAR   ZB-AH-003TCLP1 ZB-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


     NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZB003) ASH EXTRACT

SAMPLE NUMBER:
DILUTION FACTOR:
DESCRIPTION:
UNITS:

*** INORGANICS ***

PP	CAS NO	COMPOUND	ZB AH 003C02 ASH EXTRACT UG/L	ZB-AH 003DIH2O ASH EXTRACT UG/L	ZB AH 003EPTOX ASH EXTRACT UG/L	ZB AH-003SAR ASH EXTRACT UG/L	ZB AH-003TCLP1 ASH EXTRACT UG/L	ZB-AH-003TCLP2 ASH EXTRACT UG/L
4		BARIUM	140	454	191	1390	517	321
6		CADMIUM			25			132
10		COPPER	8.8	21	51	38	17	10
12		LEAD		37		22		
14		MANGANESE			250			1710
15		MERCURY			3.5			0.73
20		SODIUM	132000	126000	161000	117000	1440000	141000
21		ZINC	19	40	67	29	9.7	1580

(ZB003) ASH EXTRACT

SAMPLE NUMBER:	ZB-AH-003CO2	ZB-AH-003DIH2O	ZB-AH-003EPTOX	ZB-AH-003SAR	ZB-AH-003TCLP1	ZB-AH-003TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZB-AH-003CO2	ZB-AH-003DIH2O	ZB-AH-003EPTOX	ZB-AH-003SAR	ZB-AH-003TCLP1	ZB-AH-003TCLP2
		TOC	NA	5.52	NA	7.07	NA	NA
		AMMONIA	NA	0.10	NA	NA	NA	NA
		NITRATE	0.21	0.12	0.17	NA	0.13	0.07
		ORTHO PHOSPHATE	<0.01	<0.01	0.06	<0.01	<0.01	0.03
		TOTAL ALKALINITY	NA	430	NA	NA	NA	NA
		CHLORIDE	1310	1070	1020	NA	1340	1290
		SULFATE	662	119	950	NA	180	1110
		ALUMINUM OXIDE %	26700	213	100	5950	6770	
		CALCIUM OXIDE %	1060000	811000	3720000	699000	1860000	3610000
		MAGNESIUM OXIDE %	1090	37	119000	55	692	137000
		POTASSIUM MONOXIDE %	124000	108000	134000	115000	146000	127000
		SILICON DIOXIDE %	958	2300	5090	2330	3560	26800
		TDS	NA	2490	NA	NA	NA	NA

```
           (ZB004) ASH EXTRACT

SAMPLE NUMBER:                                  ZB-AH-004CO2   ZB-AH-004DIH2O ZB-AH-004EPTOX ZB-AH-004SAR   ZB-AH-004TCLP1 ZB-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                                    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
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```
          (ZB004) ASH EXTRACT

SAMPLE NUMBER:                          ZB-AH-004CO2  ZB-AH-004DIH2O ZB-AH-004EPTOX ZB-AH-004SAR  ZB-AH-004TCLP1 ZB-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT   ASH EXTRACT    ASH EXTRACT    ASH EXTRACT   ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP   CAS NO      COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZB001) ASH EXTRACT

SAMPLE NUMBER:			ZB-AH-004CO2	ZB-AH-004DIH2O	ZB-AH-004EPTOX	ZB-AH-004SAR	ZB-AH-004TCLP1	ZB-AH-004TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC	53					
4		BARIUM	381	1020	232	1980	1850	404
6		CADMIUM			59			
10		COPPER	11	21	33	24	15	21
12		LEAD		351		224		
11		MANGANESE			518			39
15		MERCURY			4.9			1.7
20		SODIUM	127000	157000	149000	154000	1430000	156000
21		ZINC	21	349	422	168	49	26

(ZB004) ASH EXTRACT

SAMPLE NUMBER:			ZB-AH-004CO2	ZB-AH-004DIH2O	ZB-AH-004FPTOX	ZB-AH-004SAR	ZB-AH-004TCLP1	ZB-AH-004TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		TOC	NA	3.37	NA	5.73	NA	NA
		AMMONIA	NA	0.11	NA	NA	NA	NA
		NITRATE	0.14	0.11	0.15	NA	0.15	0.14
		ORTHO PHOSPHATE	<0.01	<0.01	0.06	<0.01	<0.01	0.03
		TOTAL ALKALINITY	NA	972	NA	NA	NA	NA
		CHLORIDE	1080	1320	1280	NA	1530	1500
		SULFATE	22.9	<0.5	881	NA	10.4	720
		ALUMINUM OXIDE %	90700	167		501	1410	7760
		CALCIUM OXIDE %	737000	1250000	3630000	1160000	1810000	3260000
		MAGNESIUM OXIDE %	207	21	75100	18	55	30600
		POTASSIUM MONOXIDE %	124000	134000	129000	152000	163000	138000
		SILICON DIOXIDE %	418	591	10100	714	2050	820
		TDS	NA	3270	NA	NA	NA	NA

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          (ZB005) ASH EXTRACT

SAMPLE NUMBER:                          ZB-AH-005C02   ZB-AH-005DIH2O ZB-AH-005EPTOX ZB-AH-005SAR   ZB-AH-005TCLP1 ZB-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
        (ZB005) ASH EXTRACT

SAMPLE NUMBER:                         ZB-AH-005CO2   ZB-AH-005DIH2O ZB-AH-005FPTOX ZB-AH-005SAR   ZB-AH-005TCLP1 ZB-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                           ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZB005) ASH EXTRACT

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:			ZB-AH-005CO2 ASH EXTRACT UG/L	ZB-AH-005DIH2O ASH EXTRACT UG/L	ZB-AH-005EPTOX ASH EXTRACT UG/L	ZB-AH-005SAR ASH EXTRACT UG/L	ZB-AH-005TCLP1 ASH EXTRACT UG/L	ZB-AH-005TCLP2 ASH EXTRACT UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
4		BARIUM	240	1030	244	1150	1590	388
6		CADMIUM			50			15
10		COPPER	14	21	25	36	10	26
12		LEAD		731		293		
14		MANGANESE			396			128
15		MERCURY			9.8		0.25	4.6
20		SODIUM	130000	179000	185000	180000	1130000	183000
24		ZINC	8.6	253	457	287	37	50

(ZB005) ASH EXTRACT

SAMPLE NUMBER:	ZB-AH-005C02	ZB-AH-005DIH2O	ZB-AH-005EPTOX	ZB-AH-005SAR	ZB-AH-005TCLP1	ZB-AH-005TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						
*** GEOCHEMICAL PARAMETERS ***						
PP CAS NO COMPOUND						
TOC	NA	4.28	NA	4.52	NA	NA
AMMONIA	NA	0.10	NA	NA	NA	NA
NITRATE	0.17	0.15	0.20	NA	0.15	0.19
ORTHO PHOSPHATE	<0.01	<0.01	0.06	<0.01	<0.01	0.02
TOTAL ALKALINITY	NA	996	NA	NA	NA	NA
CHLORIDE	1570	2170	1740	NA	2030	2080
SULFATE	129	9.0	804	NA	4.4	733
ALUMINUM OXIDE %	47700	161		102	17600	1760
CALCIUM OXIDE %	873000	1300000	4000000	1530000	1960000	3640000
MAGNESIUM OXIDE %	247	21	70400	17	70	68000
POTASSIUM MONOXIDE %	128000	156000	170000	181000	203000	167000
SILICON DIOXIDE %	527	106	7570	634	1300	1460
TDS	NA	1750	NA	NA	NA	NA

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        (ZCOO1) ASH EXTRACT

SAMPLE NUMBER:                          ZC-AH-001CO2   ZC-AH-001DIH2O ZC-AH-001EPTOX ZC-AH-001SAR   ZC-AH-001TCLP1 ZC-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


     NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZC001) ASH EXTRACT

SAMPLE NUMBER:                          ZC-AH-001CO2   ZC-AH-001DIH2O ZC-AH-001EPTOX ZC-AH-001SAR   ZC-AH-001TCLP1 ZC-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZC001) ASH EXTRACT

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:			ZC-AH-001CO2 ASH EXTRACT UG/L	ZC-AH-001DIH2O ASH EXTRACT UG/L	ZC-AH-001EPTOX ASH EXTRACT UG/L	ZC-AH-001SAR ASH EXTRACT UG/L	ZC-AH-001TCLP1 ASH EXTRACT UG/L	ZC-AH-001TCLP2 ASH EXTRACT UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC						60
4		BARIUM	198	142	33	138	275	40
6		CADMIUM	77		998	6.0	693	980
8		CHROMIUM	6.8	14	69	8.3	5.6	221
10		COPPER	84	26	1600	19	50	1200
11		IRON	8.7		3160			23800
12		LEAD	95		7510	30	1940	10100
14		MANGANESE	1420	7.0	5170		2600	7370
15		MERCURY			0.67	0.27		0.44
20		SODIUM	139000	189000	158000	136000	1560000	168000
21		ZINC	11500	118	80100	30	33700	81200

(ZC001) ASH EXTRACT

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:	ZC-AH-001CO2	ZC-AH-001DIH2O	ZC-AH-001EPTOX	ZC-AH-001SAR	ZC-AH-001TCLP1	ZC-AH-001TCLP2
	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
*** GEOCHEMICAL PARAMETERS ***						
PP CAS NO COMPOUND						
TOC	NA	7.22	NA	5.54	NA	NA
AMMONIA	0.14	0.16	0.30	2.80	0.19	0.32
NITRATE	0.19	0.94	0.71	NA	0.25	15.3
ORTHO PHOSPHATE	0.01	0.01	0.20	0.01	0.01	1.67
TOTAL ALKALINITY	NA	228	NA	NA	NA	NA
CHLORIDE	173	230	226	NA	232	249
SULFATE	658	418	879	NA	893	985
ALUMINUM OXIDE %	77	67800	34400	118000		116000
CALCIUM OXIDE %	662000	192000	1550000	183000	1270000	1750000
MAGNESIUM OXIDE %	23200	97	63000	49	375000	80900
POTASSIUM MONOXIDE %	108000	150000	118000	109000	120000	126000
SILICON DIOXIDE %	20000	1520	79000	965	22400	43000
TDS	NA	1320	NA	NA	NA	NA

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          (ZC002) ASH EXTRACT

SAMPLE NUMBER:                              ZC-AH-002CO2   ZC-AH-002DIH2O ZC-AH-002EPTOX ZC-AH-002SAR   ZC-AH-002TCLP1 ZC-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                                ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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       NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZC002) ASH EXTRACT

SAMPLE NUMBER:                                  ZC-AH-002CO2   ZC-AH-002DIH2O ZC-AH-002EPTOX ZC-AH-002SAR   ZC-AH-002TCLP1 ZC-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                                    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZC002) ASH EXTRACT

SAMPLE NUMBER:			ZC-AH-002CO2	ZC-AH-002DIH2O	ZC-AH-002EPTOX	ZC-AH-002SAR	ZC-AH-002TCLP1	ZC-AH-002TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC		15	20			17
4		BARIUM	192	192	187	136	197	142
6		CADMIUM	30		1120		646	1130
8		CHROMIUM	8.8	12	72	7.5	6.6	213
10		COPPER	61	46	1010	36	71	150
11		IRON			4580			14400
12		LEAD	44		10400	38	337	11700
14		MANGANESE	972	20	8540		4200	5700
15		MERCURY		0.21		0.21	0.32	
20		SODIUM	150000	174000	144000	129000	1510000	144000
21		ZINC	1370	270	62700	96	24300	78600

(ZC002) ASH EXTRACT

SAMPLE NUMBER:			ZC-AH-002CO2	ZC-AH-002DIH2O	ZC-AH-002EPTOX	ZC-AH-002SAR	ZC-AH-002TCLP1	ZC-AH-002TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		TOC	NA	4.51	NA	3.87	NA	NA
		AMMONIA	0.12	0.19	0.25	3.02	0.16	0.18
		NITRATE	0.20	0.40	0.45	NA	0.74	0.23
		ORTHO PHOSPHATE	0.01	<0.01	0.22	0.01	0.01	2.04
		TOTAL ALKALINITY	NA	598	NA	NA	NA	NA
		CHLORIDE	193	194	202	NA	255	256
		SULFATE	709	187	727	NA	761	893
		ALUMINUM OXIDE %	70	203000	34500	106000		118000
		CALCIUM OXIDE %	737000	141000	1600000	142000	1190000	1820000
		MAGNESIUM OXIDE %	26800	318	61800	64	40300	83600
		POTASSIUM MONOXIDE %	124000	111000	114000	109000	123000	1110000
		SILICON DIOXIDE %	25100	558	75700	722	24300	8000
		TDS	NA	1190	NA	NA	NA	NA

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        (ZC003) ASH EXTRACT

SAMPLE NUMBER:                            ZC-AH-003CO2   ZC-AH-003DIH2O ZC-AH-003EPTOX ZC-AH-003SAR   ZC-AH-003TCLP1 ZC-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                              ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZC003) ASH EXTRACT

SAMPLE NUMBER:                       ZC-AH-003CO2   ZC-AH-003DIH2O ZC-AH-003EPTOX ZC-AH-003SAR   ZC-AH-003TCLP1 ZC-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                         ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP   CAS NO       COMPOUND
---- ---------- ----------------

        NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZC003) ASH EXTRACT

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:			ZC-AH-003CO2 ASH EXTRACT UG/L	ZC-AH-003DIH2O ASH EXTRACT UG/L	ZC-AH-003EPTOX ASH EXTRACT UG/L	ZC-AH-003SAR ASH EXTRACT UG/L	ZC-AH-003TCLP1 ASH EXTRACT UG/L	ZC-AH-003TCLP2 ASH EXTRACT UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC		18				54
4		BARIUM	206	139	188	163	253	12
6		CADMIUM	85		1070	5.3	1020	1380
8		CHROMIUM	7.0	16	42	5.9	6.3	265
10		COPPER	116	37	929	33	151	1200
11		IRON	5.6	11	13500	23		21300
12		LEAD	119		6900	201	719	8190
14		MANGANESE	1180	4.7	3840	6.1	3310	4910
15		MERCURY		0.32	0.23	1.1	0.44	0.32
20		SODIUM	111000	155000	129000	124000	1510000	170000
21		ZINC	7100	55	59700	75	32600	94400

(ZC003) ASH EXTRACT

SAMPLE NUMBER:	ZC-AH-003CO2	ZC-AH-003DIH2O	ZC-AH-003EPTOX	ZC-AH-003SAR	ZC-AH-003TCLP1	ZC-AH-003TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						
*** GEOCHEMICAL PARAMETERS ***						
PP CAS NO COMPOUND						
TOC	NA	7.35	NA	3.26	NA	NA
AMMONIA	0.15	0.16	0.22	2.83	0.15	0.21
NITRATE	0.40	0.06	0.31	NA	0.76	0.25
ORTHO PHOSPHATE	0.01	0.01	0.04	<0.01	0.01	1.48
TOTAL ALKALINITY	NA	479	NA	NA	NA	NA
CHLORIDE	178	181	188	NA	215	258
SULFATE	751	412	756	NA	984	962
ALUMINUM OXIDE %	79	89900	20000	88200		118000
CALCIUM OXIDE %	759000	193000	1300000	199000	1240000	1690000
MAGNESIUM OXIDE %	30400	72	52300	116	46400	80800
POTASSIUM MONOXIDE %	116000	139000	110000	108000	124000	135000
SILICON DIOXIDE %	28900	888	64500	518	26800	48700
TDS	NA	1050	NA	NA	NA	NA

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          (ZC004) ASH EXTRACT

SAMPLE NUMBER:                                ZC-AH-004CO2   ZC-AH-004DIH2O ZC-AH-004EPTOX ZC-AH-004SAR   ZC-AH-004TCLP1 ZC-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                                  ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


       NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZC004) ASH EXTRACT

SAMPLE NUMBER:                            ZC-AH-004CO2   ZC-AH-004DIH2O ZC-AH-004EPTOX ZC-AH-004SAR   ZC-AH-004TCLP1 ZC-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                              ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZC004) ASH EXTRACT

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:			ZC-AH-004CO2 ASH EXTRACT UG/L	ZC-AH-004D1H2O ASH EXTRACT UG/L	ZC-AH-004EPTOX ASH EXTRACT UG/L	ZC-AH-004SAR ASH EXTRACT UG/L	ZC-AH-004TCLP1 ASH EXTRACT UG/L	ZC-AH-004TCLP2 ASH EXTRACT UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC		25				
4		BARIUM	245	171	198	182	253	223
6		CADMIUM	110		897		970	758
8		CHROMIUM	9.8	8.6	36	6.2	6.1	162
10		COPPER	33	12	2300	14	66	41
11		IRON	33		24300	72		46300
12		LEAD	101	53	5180		1610	9470
14		MANGANESE	788	2.1	2950		5170	2750
15		MERCURY		0.32			0.49	
20		SODIUM	153000	140000	140000	127000	1640000	123000
24		ZINC	127000	37	57000	89	47400	51900

(ZC004) ASH EXTRACT

PP	CAS NO	COMPOUND	ZC-AH-004CO2	ZC-AH-004DIH2O	ZC-AH-004EPTOX	ZC-AH-004SAR	ZC-AH-004TCLP1	ZC-AH-004TCLP2
SAMPLE NUMBER:			ZC-AH-004CO2	ZC-AH-004DIH2O	ZC-AH-004EPTOX	ZC-AH-004SAR	ZC-AH-004TCLP1	ZC-AH-004TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
		TOC	NA	5.08	NA	2.58	NA	NA
		AMMONIA	0.19	0.22	0.21	2.88	0.19	0.22
		NITRATE	0.07	0.15	0.36	NA	1.33	0.08
		ORTHO PHOSPHATE	<0.01	0.01	<0.01	<0.01	<0.01	0.79
		TOTAL ALKALINITY	NA	696	NA	NA	NA	NA
		CHLORIDE	187	193	183	NA	228	196
		SULFATE	587	287	1360	NA	938	536
		ALUMINUM OXIDE %	106	155000	23700	74500		98200
		CALCIUM OXIDE %	621000	193000	1310000	170000	1330000	1590000
		MAGNESIUM OXIDE %	34700	96	47800	375	42300	59700
		POTASSIUM MONOXIDE %	119000	116000	112000	101000	134000	91200
		SILICON DIOXIDE %	31500	503	69100	1330	29400	17700
		TDS	NA	1160	NA	NA	NA	NA

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         (ZC005) ASH EXTRACT

SAMPLE NUMBER:                               ZC-AH-005CO2   ZC-AH-005DIH2O ZC-AH-005EPTOX ZC-AH-005SAR   ZC-AH-005TCLP1 ZC-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                                 ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
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          (ZC005) ASH EXTRACT

SAMPLE NUMBER:                                ZC-AH-005CO2   ZC-AH-005DIH2O ZC-AH-005EPTOX ZC-AH-005SAR   ZC-AH-005TCLP1 ZC-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                                  ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
---- ----------- ----------------

       NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZC005) ASH EXTRACT

SAMPLE NUMBER:			ZC-AH 005CO2	ZC-AH 005DIH2O	ZC-AH-005EPTOX	ZC-AH-005SAR	ZC-AH-005TCLP1	ZC-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC			22			24
4		BARIUM	148	141	23	129	201	28
6		CADMIUM	84		1200		761	1260
8		CHROMIUM	8.5	11	65	7.9	8.0	234
10		COPPER	64	12	1390	8.5	291	568
11		IRON	12		4670	97	113	26800
12		LEAD	159		6830		2960	8090
14		MANGANESE	834		2600	5.7	1900	3760
15		MERCURY			0.56			
20		SODIUM	166000	184000	155000	160000	1560000	164000
21		ZINC	7740	133	66500	132	12500	86000

(ZC005) ASH EXTRACT

SAMPLE NUMBER:			ZC-AH-005CO2	ZC-AH-005DIH2O	ZC-AH-005EPTOX	ZC-AH-005SAR	ZC-AH-005TCLP1	ZC-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
3		ARSENIC			22			24
4		BARIUM	148	141	23	129	201	28
6		CADMIUM	84		1200		761	1260
8		CHROMIUM	8.5	11	65	7.9	8.0	234
10		COPPER	64	12	1390	8.5	291	568
11		IRON	12		4670	97	113	26800
12		LEAD	159		6830		2960	8090
14		MANGANESE	834		2600	5.7	1900	3760
15		MERCURY			0.56			
20		SODIUM	166000	184000	155000	160000	1560000	164000
21		ZINC	7740	133	66500	132	12500	86000

(ZC005) ASH EXTRACT

SAMPLE NUMBER:			ZC-AH-005CO2	ZC-AH-005DIH2O	ZC-AH-005EPTOX	ZC-AH-005SAR	ZC-AH-005TCLP1	ZC-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		TOC	NA	5.82	NA	5.15	NA	NA
		AMMONIA	0.15	0.24	0.19	2.88	0.16	0.21
		NITRATE	1.59	0.10	0.56	NA	0.78	0.21
		ORTHO PHOSPHATE	0.02	0.01	0.11	0.01	0.01	1.12
		TOTAL ALKALINITY	NA	368	NA	NA	NA	NA
		CHLORIDE	195	207	190	NA	189	281
		SULFATE	777	388	1650	NA	585	1140
		ALUMINUM OXIDE %	85	50100	32300	82100	1320	110000
		CALCIUM OXIDE %	684000	145000	1350000	173000	1110000	1500000
		MAGNESIUM OXIDE %	25800	42	53300	430	39400	74800
		POTASSIUM MONOXIDE %	142000	159000	127000	136000	83200	126000
		SILICON DIOXIDE %	26900	1560	20900	1410	51700	7170
		TDS	NA	1120	NA	NA	NA	NA

(ZC005) ASH EXTRACT

SAMPLE NUMBER:	ZC-AH-005CO2	ZC-AH-005DIH2O	ZC-AH-005EPTOX	ZC-AH-005SAR	ZC-AH-005TCLP1	ZC-AH-005TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZC-AH-005CO2	ZC-AH-005DIH2O	ZC-AH-005EPTOX	ZC-AH-005SAR	ZC-AH-005TCLP1	ZC-AH-005TCLP2
		TOC	NA	5.82	NA	5.15	NA	NA
		AMMONIA	0.15	0.24	0.19	2.88	0.16	0.21
		NITRATE	1.59	0.10	0.56	NA	0.78	0.21
		ORTHO PHOSPHATE	0.02	0.01	0.11	0.01	0.01	1.12
		TOTAL ALKALINITY	NA	368	NA	NA	NA	NA
		CHLORIDE	195	207	190	NA	189	281
		SULFATE	777	388	1650	NA	585	1140
		ALUMINUM OXIDE %	85	50100	32300	82100	1320	110000
		CALCIUM OXIDE %	684000	145000	1350000	173000	1110000	1500000
		MAGNESIUM OXIDE %	25800	42	53300	430	39400	74800
		POTASSIUM MONOXIDE %	142000	159000	127000	136000	83200	126000
		SILICON DIOXIDE %	26900	1560	20900	1410	51700	7170
		TDS	NA	1120	NA	NA	NA	NA

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SAMPLE NUMBER:                          ZD-AH-001CO2   ZD-AH-001DIH2O ZD-AH-001EPTOX ZD-AH-001SAR   ZD-AH-001TCLP1 ZD-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO        COMPOUND
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     65-85-0    BENZOIC ACID                            26JT
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SAMPLE NUMBER:                        ZD-AH-001CO2   ZD-AH-001DIH2O ZD-AH-001EPTOX ZD-AH-001SAR   ZD-AH-001TCLP1 ZD-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                          ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP   CAS NO        COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
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SAMPLE NUMBER:			ZD-AH-001CO2	ZD-AH-001DIH2O	ZD-AH-001EPTOX	ZD-AH-001SAR	ZD-AH-001TCLP1	ZD-AH-001TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
1		BARIUM	278	201	290	262	318	431
6		CADMIUM	251		195		129	636
8		CHROMIUM					8.0	193
10		COPPER	75	64	21	82	11	178
11		IRON	45		27100		7220	75500
12		LEAD	501		3490		10500	26400
14		MANGANESE	1330		1320		1940	3350
15		MERCURY	0.47			0.37		
20		SODIUM	40100	32500	37200	36600	1380000	46200
21		ZINC	26400	17	30300	35	56900	85000

SAMPLE NUMBER:	ZD-AH-001CO2	ZD-AH-001DIH2O	ZD-AH-001EPTOX	ZD-AH-001SAR	ZD-AH-001TCLP1	ZD-AH-001TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						
*** GEOCHEMICAL PARAMETERS ***						
PP CAS NO COMPOUND						
TOC	NA	18.9	NA	19.7	NA	NA
AMMONIA	0.09	0.11	0.12	4.10	0.12	0.16
NITRATE	0.20	0.14	0.16	NA	0.05	0.04
ORTHO PHOSPHATE	0.06	<0.01	0.01	<0.01	0.04	1.13
TOTAL ALKALINITY	NA	254	NA	NA	NA	NA
CHLORIDE	63.6	55.5	43.5	NA	99.1	81.9
SULFATE	375	249	197	NA	360	447
ALUMINUM OXIDE %	204	85200	4870	72300	6090	88600
CALCIUM OXIDE %	173000	203000	601000	246000	666000	949000
MAGNESIUM OXIDE %	41300	91	51000	113	62900	101000
POTASSIUM MONOXIDE %	25300	20500	19200	24100	18700	23500
SILICON DIOXIDE %	29700	402	29100	880	33100	129000
TDS	NA	625	NA	NA	NA	NA

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          (ZD002) ASH EXTRACT

SAMPLE NUMBER:                         ZD-AH-002CO2   ZD-AH-002DIH2O ZD-AH-002EPTOX ZD-AH-002SAR   ZD-AH-002TCLP1 ZD-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                           ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
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     NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZD002) ASH EXTRACT

SAMPLE NUMBER:                          ZD-AH-002CO2   ZD-AH-002DIH2O ZD-AH-002EPTOX ZD-AH-002SAR   ZD-AH-002TCLP1 ZD-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP   CAS NO      COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZD002) ASH EXTRACT

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:			ZD-AH-002CO2 ASH EXTRACT UG/L	ZD-AH-002DIH2O ASH EXTRACT UG/L	ZD-AH-002EPTOX ASH EXTRACT UG/L	ZD-AH-002SAR ASH EXTRACT UG/L	ZD-AH-002TCLP1 ASH EXTRACT UG/L	ZD-AH-002TCLP2 ASH EXTRACT UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
1		BARIUM	129	259	162	209	418	110
6		CADMIUM	354		1100		1080	1560
8		CHROMIUM			49			799
10		COPPER	148	77	672	70	858	125
11		IRON			1200			32800
12		LEAD	356		19700		10200	23900
14		MANGANESE	934		2710		2080	4750
15		MERCURY	0.52	0.90		0.27	0.43	
20		SODIUM	49800	42600	52500	42100	1430000	68300
21		ZINC	30600	9.7	95600	33	75100	164000

(ZD002) ASH EXTRACT

SAMPLE NUMBER:			ZD-AH-002CO2	ZD-AH-002DIH2O	ZD-AH-002EPTOX	ZD-AH-002SAR	ZD-AH-002TCLP1	ZD-AH-002TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND						
		TOC	NA	9.19	NA	9.94	NA	NA
		AMMONIA	0.07	0.11	0.15	3.77	0.12	0.19
		NITRATE	0.26	0.11	0.06	NA	0.06	0.12
		ORTHO PHOSPHATE	<0.01	<0.01	0.06	<0.01	0.01	0.48
		TOTAL ALKALINITY	NA	249	NA	NA	NA	NA
		CHLORIDE	77.2	70.2	82.2	NA	108	111
		SULFATE	572	371	566	NA	703	872
		ALUMINUM OXIDE %		88500	18200	84200	462	103000
		CALCIUM OXIDE %	759000	255000	1160000	241000	934000	1470000
		MAGNESIUM OXIDE %	43100	83	78700	52	70200	121000
		POTASSIUM MONOXIDE %	33400	30400	34100	31200	32000	40900
		SILICON DIOXIDE %	27900	479	45000	802	32400	143000
		TDS	NA	842	NA	NA	NA	NA

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        (ZD003) ASH EXTRACT

SAMPLE NUMBER:                          ZD-AH-003CO2    ZD-AH-003DIH2O ZD-AH-003EPTOX ZD-AH-003SAR    ZD-AH-003TCLP1 ZD-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT     ASH EXTRACT    ASH EXTRACT    ASH EXTRACT     ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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          (ZD003) ASH EXTRACT

SAMPLE NUMBER:                          ZD-AH-003CO2   ZD-AH-003DIH2O ZD-AH-003EPTOX ZD-AH-003SAR   ZD-AH-003TCLP1 ZD-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP   CAS NO        COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZD003) ASH EXTRACT

SAMPLE NUMBER:			ZD-AH-003CO2	ZD-AH-003D1H2O	ZD-AH-003EPTOX	ZD-AH-003SAR	ZD-AH-003TCLP1	ZD-AH-003TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
1		BARIUM	110	252	190	236	117	385
6		CADMIUM	314		576		1150	1300
8		CHROMIUM						232
10		COPPER	42	31	1550	32	74	302
11		IRON			13300			47500
12		LEAD	127		4010	43	6610	25700
11		MANGANESE	1110		2070		3110	1780
15		MERCURY	0.29	0.59		0.53	0.53	
20		SODIUM	24800	31000	33600	29600	1400000	48600
21		ZINC	26400	5.4	53900	21	79500	131000

(ZD003) ASH EXTRACT

SAMPLE NUMBER:			ZD-AH-003CO2	ZD-AH-003DIH2O	ZD-AH-003EPTOX	ZD-AH-003SAR	ZD-AH-003TCLP1	ZD-AH-003TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		TOC	NA	10.7	NA	10.2	NA	NA
		AMMONIA	0.07	0.11	0.15	3.56	0.14	0.20
		NITRATE	0.23	0.18	0.03	NA	0.07	0.01
		ORTHO PHOSPHATE	<0.01	<0.01	<0.01	<0.01	0.01	1.66
		TOTAL ALKALINITY	NA	288	NA	NA	NA	NA
		CHLORIDE	39.7	54.5	48.3	NA	109	89.3
		SULFATE	336	247	238	NA	625	497
		ALUMINUM OXIDE %	46	97900	16500	73800	344	130000
		CALCIUM OXIDE %	398000	199000	592000	209000	881000	995000
		MAGNESIUM OXIDE %	35000	71	42600	98	73000	97600
		POTASSIUM MONOXIDE %	15900	18800	17000	20000	21500	22900
		SILICON DIOXIDE %	24000	118	27400	989	33200	136000
		TDS	NA	639	NA	NA	NA	NA

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          (ZD004) ASH EXTRACT

SAMPLE NUMBER:                            ZD-AH-004CO2   ZD-AH-004DIH2O ZD-AH-004EPTOX ZD-AH-004SAR   ZD-AH-004TCLP1 ZD-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                              ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
        (ZD004) ASH EXTRACT

SAMPLE NUMBER:                           ZD-AH-004CO2   ZD-AH-004DIH2O ZD-AH-004EPTOX ZD-AH-004SAR   ZD-AH-004TCLP1 ZD-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                             ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
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     NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZD004) ASH EXTRACT

SAMPLE NUMBER:			ZD-AH-004C02	ZD-AH-004D1H2O	ZD-AH-004EPTOX	ZD-AH-004SAR	ZD-AH-004TCLP1	ZD-AH-004TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
1		BARIUM	227	240	218	227	282	290
6		CADMIUM	167		614		522	702
8		CHROMIUM			8.7			145
10		COPPER	246	53	488	49	23	593
11		IRON			8160			53000
12		LEAD	202		12900		4050	22700
14		MANGANESE	1350		2930		2550	3900
15		MERCURY	0.77	0.27	0.24	0.27		
20		SODIUM	29500	24100	37800	25600	1420000	40100
21		ZINC	15200	24	70500	12	58400	70600

(ZD004) ASH EXTRACT

SAMPLE NUMBER:	ZD-AH-004CO2	ZD-AH-004DIH2O	ZD-AH-004EPTOX	ZD-AH-004SAR	ZD-AH-004TCLP1	ZD-AH-004TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZD-AH-004CO2	ZD-AH-004DIH2O	ZD-AH-004EPTOX	ZD-AH-004SAR	ZD-AH-004TCLP1	ZD-AH-004TCLP2
		TOC	NA	14.1	NA	15.2	NA	NA
		AMMONIA	0.07	0.08	0.14	3.91	0.13	0.19
		NITRATE	0.25	0.03	0.06	NA	0.05	0.03
		ORTHO PHOSPHATE	<0.01	<0.01	0.03	<0.01	0.01	1.56
		TOTAL ALKALINITY	NA	201	NA	NA	NA	NA
		CHLORIDE	45.9	34.2	58.7	NA	83.9	68.6
		SULFATE	523	265	629	NA	660	637
		ALUMINUM OXIDE %	39	71000	16200	73800	422	96400
		CALCIUM OXIDE %	550000	200000	1250000	202000	970000	1670000
		MAGNESIUM OXIDE %	45300	156	85100	319	61200	108000
		POTASSIUM MONOXIDE %	17700	13100	19300	16500	16900	18600
		SILICON DIOXIDE %	26100	642	49100	703	27500	123000
		TDS	NA	598	NA	NA	NA	NA

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        (ZD005) ASH EXTRACT

SAMPLE NUMBER:                         ZD-AH-005CO2   ZD-AH-005DIH2O ZD-AH-005EPTOX ZD-AH-005SAR   ZD-AH-005TCLP1 ZD-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                           ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
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          (ZD005) ASH EXTRACT

SAMPLE NUMBER:                                  ZD-AH-005CO2   ZD-AH-005DIH2O ZD-AH-005FPTOX ZD-AH-005SAR   ZD-AH-005TCLP1 ZD-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                                    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO        COMPOUND
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     NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZD005) ASH EXTRACT

SAMPLE NUMBER:			ZD-AH-005CO2	ZD-AH-005DIH2O	ZD-AH-005EPTOX	ZD-AH-005SAR	ZD-AH-005TCLP1	ZD-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
4		BARIUM	502	285	239	166	245	586
6		CADMIUM	169		570		126	601
8		CHROMIUM						155
10		COPPER	62	80	85	65	8.5	1400
11		IRON			10800		1040	103000
12		LEAD	170		9070		6060	25200
14		MANGANESE	1420		4900		1950	5750
15		MERCURY			0.29	0.32		
20		SODIUM	26900	33700	36600	24200	1400000	38700
24		ZINC	18800	19	50300	16	43100	61000

(ZD005) ASH EXTRACT

SAMPLE NUMBER:			ZD-AH-005CO2	ZD-AH-005DIH2O	ZD-AH-005EPTOX	ZD-AH-005SAR	ZD-AH-005TCLP1	ZD-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		TOC	NA	17.0	NA	14.3	NA	NA
		AMMONIA	0.08	0.17	0.20	3.74	0.13	0.18
		NITRATE	0.24	0.04	0.08	NA	0.03	0.03
		ORTHO PHOSPHATE	<0.01	<0.01	0.02	0.01	0.01	1.38
		TOTAL ALKALINITY	NA	212	NA	NA	NA	NA
		CHLORIDE	44.6	59.1	73.8	NA	90.8	56.4
		SULFATE	148	254	440	NA	531	438
		ALUMINUM OXIDE %		80600	12600	77900	3370	102000
		CALCIUM OXIDE %	506000	208000	935000	194000	796000	961000
		MAGNESIUM OXIDE %	59300	114	86500	145	56300	94100
		POTASSIUM MONOXIDE %	12300	17900	38600	14500	14600	15100
		SILICON DIOXIDE %	29000	626	38000	877	25600	118000
		TDS	NA	640	NA	NA	NA	NA

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SAMPLE NUMBER:                          ZE-AH-001CO2   ZE-AH-001DIH2O ZE-AH-001EPTOX ZE-AH-001SAR   ZE-AH-001TCLP1 ZE-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
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     65-85-0    BENZOIC ACID                           66T
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SAMPLE NUMBER:                           ZE-AH-001CO2   ZE-AH-001DIH2O ZE-AH-001EPTOX ZE-AH-001SAR   ZE-AH-001TCLP1 ZE-AH-001TCLP2
DILUTION FACTOR:
DESCRIPTION:                             ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
---- ---------- ----------------


      NO PARAMETERS DETECTED FOR THIS CATEGORY
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PP	CAS NO	COMPOUND	ZE-AH-001CO2	ZE-AH-001DIH20	ZE-AH-001EPTOX	ZE-AH-001SAR	ZE-AH-001TCLP1	ZE-AH-001TCLP2
SAMPLE NUMBER:			ZE-AH-001CO2	ZE-AH-001DIH20	ZE-AH-001EPTOX	ZE-AH-001SAR	ZE-AH-001TCLP1	ZE-AH-001TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
4		BARIUM	182	196	228	317	238	330
6		CADMIUM	63		637		349	575
8		CHROMIUM			59			289
10		COPPER	274	177	484	164	58	50
11		IRON			52200			136000
12		LEAD	85		10700		169	8810
14		MANGANESE	909		2740		1350	3560
15		MERCURY		0.85	0.41	1.0		0.53
20		SODIUM	85600	72700	82800	68000	1450000	86200
21		ZINC	8810	20	82400	41	11900	82700

SAMPLE NUMBER:
DILUTION FACTOR:
DESCRIPTION:
UNITS:

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZE-AH-001CO2	ZE-AH-001DIH2O	ZE-AH-001EPTOX	ZE-AH-001SAR	ZE-AH-001TCLP1	ZE-AH-001TCLP2
			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
		TOC	NA	21.3	NA	20.8	NA	NA
		AMMONIA	0.27	0.27	0.51	4.11	0.32	0.44
		NITRATE	0.39	0.08	0.17	NA	0.16	0.16
		ORTHO PHOSPHATE	<0.01	<0.01	0.50	<0.01	<0.01	1.99
		TOTAL ALKALINITY	NA	169	NA	NA	NA	NA
		CHLORIDE	486	448	387	NA	419	470
		SULFATE	697	161	825	NA	1020	1040
		ALUMINUM OXIDE %		47400	90600	50000	86	152000
		CALCIUM OXIDE %	1020000	313000	2030000	352000	1360000	2130000
		MAGNESIUM OXIDE %	45000	115	100000	136	61000	116000
		POTASSIUM MONOXIDE %	55400	46600	54400	45700	42900	50200
		SILICON DIOXIDE %	25000	1320	50900	1100	11500	120000
		TDS	NA	1130	NA	NA	NA	NA

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        (ZE002) ASH EXTRACT

SAMPLE NUMBER:                          ZE-AH-002CO2   ZE-AH-002DIH2O ZE-AH-002EPTOX ZE-AH-002SAR   ZE-AH-002TCLP1 ZE-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP   CAS NO       COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
        (ZE002) ASH EXTRACT

SAMPLE NUMBER:                              ZE-AH-002CO2   ZE-AH-002DIH2O ZE-AH-002EPTOX ZE-AH-002SAR   ZE-AH-002TCLP1 ZE-AH-002TCLP2
DILUTION FACTOR:
DESCRIPTION:                                ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZE002) ASH EXTRACT

SAMPLE NUMBER:			ZE-AH-002CO2	ZE-AH-002DIH2O	ZE-AH-002EPTOX	ZE-AH-002SAR	ZE-AH-002TCLP1	ZE-AH-002TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
4		BARIUM	170	190	175	408	161	249
6		CADMIUM	17		724		231	685
8		CHROMIUM			86			216
10		COPPER	184	123	5170	127	10	1030
11		IRON			49100			81500
12		LEAD	22		9640		88	6340
14		MANGANESE	618		4910		1180	3810
15		MERCURY		.80	0.24	0.48		2.1
20		SODIUM	68700	61300	83600	63600	1100000	80400
24		ZINC	2450	35	57600	66	16300	54700

(ZE002) ASH EXTRACT

SAMPLE NUMBER:	ZE-AH-002CO2	ZE-AH-002DIH2O	ZE-AH-002EPTOX	ZE-AH-002SAR	ZE-AH-002TCLP1	ZE-AH-002TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						
*** GEOCHEMICAL PARAMETERS ***						
PP CAS NO COMPOUND						
TOC	NA	16.3	NA	17.8	NA	NA
AMMONIA	0.28	0.30	0.39	3.87	0.32	0.34
NITRATE	0.39	0.09	0.19	NA	0.12	0.16
ORTHO PHOSPHATE	<0.01	<0.01	1.01	<0.01	<0.01	1.33
TOTAL ALKALINITY	NA	171	NA	NA	NA	NA
CHLORIDE	471	145	481	NA	460	513
SULFATE	635	140	802	NA	911	926
ALUMINUM OXIDE %		19600	117000	38100		138000
CALCIUM OXIDE %	920000	364000	2100000	389000	1340000	2110000
MAGNESIUM OXIDE %	41300	111	97600	128	54500	113000
POTASSIUM MONOXIDE %	42600	37700	69800	41900	38400	64400
SILICON DIOXIDE %	19800	1870	57300	1250	9620	123000
TDS	NA	1110	NA	NA	NA	NA

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        (ZE003) ASH EXTRACT

SAMPLE NUMBER:                         ZE-AH-003CO2   ZE-AH-003DIH2O ZE-AH-003EPTOX ZE-AH-003SAR   ZE-AH-003TCLP1 ZE-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                           ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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         (ZE003) ASH EXTRACT

SAMPLE NUMBER:                               ZE-AH-003CO2   ZE-AH-003DIH2O ZE-AH-003FPTOX ZE-AH-003SAR   ZE-AH-003TCLP1 ZE-AH-003TCLP2
DILUTION FACTOR:
DESCRIPTION:                                 ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO        COMPOUND
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     NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZE003) ASH EXTRACT

SAMPLE NUMBER:			ZE-AH-003CO2	ZE-AH-003DIH2O	ZE-AH-003EPTOX	ZE-AH-003SAR	ZE-AH-003TCLP1	ZE-AH-003TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
4		BARIUM	178	428	206	330	458	384
6		CADMIUM	117		678		29	524
8		CHROMIUM			84			239
10		COPPER	142	134	2220	88	119	39
11		IRON	142		55300			162000
12		LEAD	45		7790			4110
14		MANGANESE	1560		2740		364	3970
15		MERCURY	6.3	0.96	0.59	0.64		0.27
20		SODIUM	79100	82700	80800	62200	1590000	85000
24		ZINC	9850	35	48000	42	222	56700

(ZE003) ASH EXTRACT

SAMPLE NUMBER:	ZE-AH-003CO2	ZE-AH-003DIH2O	ZE-AH-003EPTOX	ZE-AH-003SAR	ZE-AH-003TCLP1	ZE-AH-003TCLP2
DILUTION FACTOR:						
DESCRIPTION:	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:						

*** GEOCHEMICAL PARAMETERS ***

PP	CAS NO	COMPOUND	ZE-AH-003CO2	ZE-AH-003DIH2O	ZE-AH-003EPTOX	ZE-AH-003SAR	ZE-AH-003TCLP1	ZE-AH-003TCLP2
		TOC	NA	17.8	NA	14.9	NA	NA
		AMMONIA	0.30	0.46	0.44	3.98	0.35	0.44
		NITRATE	0.41	0.17	0.19	NA	0.21	0.13
		ORTHO PHOSPHATE	<0.01	<0.01	0.95	<0.01	0.02	1.59
		TOTAL ALKALINITY	NA	162	NA	NA	NA	NA
		CHLORIDE	709	702	583	NA	818	693
		SULFATE	650	169	719	NA	891	935
		ALUMINUM OXIDE %	51	27800	150000	50500	159	123000
		CALCIUM OXIDE %	1200000	538000	2100000	475000	1710000	2200000
		MAGNESIUM OXIDE %	36900	188	82400	170	37600	98900
		POTASSIUM MONOXIDE %	57700	61200	57000	46400	59400	56900
		SILICON DIOXIDE %	31300	1170	65700	911	5050	123000
		TDS	NA	1690	NA	NA	NA	NA

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        (ZE004) ASH EXTRACT

SAMPLE NUMBER:                         ZE-AH-004CO2   ZE-AH-004DIH2O ZE-AH-004EPTOX ZE-AH-004SAR   ZE-AH-004TCLP1 ZE-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                           ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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          (ZE004) ASH EXTRACT

SAMPLE NUMBER:                                   ZE-AH-004CO2   ZE-AH-004DIH2O ZE-AH-004EPTOX ZE-AH-004SAR   ZE-AH-004TCLP1 ZE-AH-004TCLP2
DILUTION FACTOR:
DESCRIPTION:                                     ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP   CAS NO      COMPOUND
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        NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZE004) ASH EXTRACT

SAMPLE NUMBER:			ZE-AH-001CO2	ZE-AH-001DIH2O	ZE-AH-001EPTOX	ZE-AH-001SAR	ZE-AH-001TCLP1	ZE-AH-004TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
1		BARIUM	530	135	173	302	299	408
6		CADMIUM	32		499		198	469
8		CHROMIUM			83			187
10		COPPER	186	325	1680	391	76	12
11		IRON			82000			122000
12		LEAD	69		15400	112	34	6590
14		MANGANESE	857		2980		4060	3360
15		MERCURY			0.65	0.22		0.80
20		SODIUM	74300	68900	74300	62400	1490000	71000
24		ZINC	2680	91	53600	192	3790	49800

(ZE004) ASH EXTRACT

SAMPLE NUMBER: DILUTION FACTOR: DESCRIPTION: UNITS:	ZE-AH-004CO2 ASH EXTRACT	ZE-AH-004DIH2O ASH EXTRACT	ZE-AH-004EPTOX ASH EXTRACT	ZE-AH-004SAR ASH EXTRACT	ZE-AH-004TCLP1 ASH EXTRACT	ZE-AH-004TCLP2 ASH EXTRACT
*** GEOCHEMICAL PARAMETERS ***						
PP CAS NO COMPOUND						
TOC	NA	23.3	NA	24.9	NA	NA
AMMONIA	0.38	0.42	0.61	4.03	0.46	0.50
NITRATE	1.23	0.16	0.22	NA	0.11	0.18
ORTHO PHOSPHATE	<0.01	<0.01	0.74	<0.01	0.02	1.01
TOTAL ALKALINITY	NA	164	NA	NA	NA	NA
CHLORIDE	429	437	392	NA	477	416
SULFATE	919	144	926	NA	1230	1090
ALUMINUM OXIDE %		20500	134000	1960		106000
CALCIUM OXIDE %	1170000	377000	2050000	473000	1730000	2200000
MAGNESIUM OXIDE %	11300	100	103000	84	57300	106000
POTASSIUM MONOXIDE %	46800	43800	15200	41200	42000	40800
SILICON DIOXIDE %	26700	2200	61100	2660	10100	124000
TDS	NA	1120	NA	NA	NA	NA

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          (ZE005) ASH EXTRACT

SAMPLE NUMBER:                          ZE-AH-005CO2   ZE-AH-005DIH2O ZE-AH-005EPTOX ZE-AH-005SAR   ZE-AH-005TCLP1 ZE-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                            ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** BASE/NEUTRALS ***

 PP    CAS NO       COMPOUND
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     NO PARAMETERS DETECTED FOR THIS CATEGORY
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        (ZE005) ASH EXTRACT

SAMPLE NUMBER:                       ZE-AH-005CO2   ZE-AH-005DIH2O ZE-AH-005EPTOX ZE-AH-005SAR   ZE-AH-005TCLP1 ZE-AH-005TCLP2
DILUTION FACTOR:
DESCRIPTION:                         ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT    ASH EXTRACT
UNITS:
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*** ACIDS ***

 PP    CAS NO        COMPOUND
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      NO PARAMETERS DETECTED FOR THIS CATEGORY
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(ZE005) ASH EXTRACT

SAMPLE NUMBER:			ZE-AH-005CO2	ZE-AH-005DIH2O	ZE-AH-005EPTOX	ZE-AH-005SAR	ZE-AH-005TCLP1	ZE-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:			UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
*** INORGANICS ***								
PP	CAS NO	COMPOUND						
4		BARIUM	205	355	183	310	170	222
6		CADMIUM	29		352		81	301
8		CHROMIUM			19			141
10		COPPER	76	133	3020	117	5.0	16
11		IRON			36600			82300
12		LEAD	31		7580	115	51	6830
14		MANGANESE	1040		3000		1090	3070
15		MERCURY				0.48		0.27
20		SODIUM	64400	58500	66200	53200	1410000	66800
21		ZINC	3250	65	48000	104	1860	36900

(ZE005) ASH EXTRACT

SAMPLE NUMBER:			ZE-AH-005CO2	ZE-AH-005DIH2O	ZE-AH-005EPTOX	ZE-AH-005SAR	ZE-AH-005TCLP1	ZE-AH-005TCLP2
DILUTION FACTOR:								
DESCRIPTION:			ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT	ASH EXTRACT
UNITS:								
*** GEOCHEMICAL PARAMETERS ***								
PP	CAS NO	COMPOUND						
		TOC	NA	16.6	NA	15.8	NA	NA
		AMMONIA	0.24	0.20	0.36	3.72	0.21	0.26
		NITRATE	0.14	0.16	0.18	NA	0.18	0.16
		ORTHO PHOSPHATE	<0.01	<0.01	0.12	<0.01	0.02	0.75
		TOTAL ALKALINITY	NA	234	NA	NA	NA	NA
		CHLORIDE	341	317	328	NA	342	334
		SULFATE	658	190	798	NA	961	883
		ALUMINUM OXIDE %	52	4570	46800	3780		104000
		CALCIUM OXIDE %	914000	376000	1920000	361000	1350000	1990000
		MAGNESIUM OXIDE %	47800	100	74900	59	52900	89000
		POTASSIUM MONOXIDE %	38000	35800	37300	34400	34500	35500
		SILICON DIOXIDE %	32400	3990	46800	3770	12300	136000
		TDS	NA	1160	NA	NA	NA	NA